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APPLYING TOTAL QUALITY LEADERSHIP TO AN AVIATION SQUADRON

by

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This thesis describes an adaptation of the NPRDC TQM process improvement model for a fleet squadron which includes the Shewart Cycle, customer supplier relationships, and mission deployment. Dr. W. Edwards Deming's 14 points are discussed in the context of the squadron environment. Continuous process improvement tools are explained and demonstrated using squadron examples.

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Applying Total Quality Leadership to an Aviation Squadron

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ABSTRACT

The implementation of Total Quality Leadership has been successful in several Department of Defense organizations. However, an aviation squadron provides an unique environment for the application of TQL.

This thesis describes an adaptation of the NPRDC TQM process improvement model for a fleet squadron which includes the Shewart Cycle, customer supplier relationships, and mission deployment. Dr. W. Edwards Deming's 14 points are discussed in the context of the squadron environment. Continuous process improvement tools are explained and demonstrated using squadron examples.

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I. INTRODUCTION

A. OBJECTIVE AND RESEARCH QUESTIONS

1. The Objective

This thesis will show how Total Quality Leadership (TQL) can be taken from theory and operationalized in a fleet aircraft squadron. The objective is to demonstrate the application and relevance of Dr. W. Edward Deming's fourteen points, customer/supplier relationships and statistical tools in an operational squadron. The intent is for this thesis to serve as a model for discussion for activities implementing TQL. This thesis is not intended to be used as a recipe or guide for implementing or using TQL.

2. The Research Questions

The following questions will be researched by the thesis:

a. Primary Research Question

How can Total Quality Leadership be applied in a naval aviation squadron?

b. Subsidiary Questions

How do Deming's fourteen points apply to the squadron organization?

How can the NPRDC TQM process improvement model fit into a squadron organization?

What statistical tools can be used to measure squadron processes?

How will Process Action Teams (PAT), Quality Management Boards (QMB) and other TQL born teams and committees fit and work within the organizational structure of a squadron?

B. SCOPE, LIMITATIONS, AND ASSUMPTIONS

1. Scope

This thesis briefly reviews the principles of Total Quality Leadership and looks specifically at the Department of the Navy (DON) TQL philosophy as it pertains to the squadron environment. This thesis will not explore the issue of whether or not Total Quality Leadership can or should be applied to an aircraft squadron. This thesis will not propose a specific implementation plan for an aircraft squadron, nor suggest a time line which will yield a TQL organizational change. It is an exploratory study of the applications of TQL in a fleet squadron.

2. Limitations

The foundation of this thesis is six months of concentrated reading and study of current literature available on the philosophy of Total Quality. It is based on personal interviews with TQL facilitators in civilian and government organizations and the analysis of hypothetical and/or simulated data by two squadron experienced officers in view of what would, in real practice, be done by a PAT.

There are numerous TQL strategies and models that may be used to implement TQL. This thesis is not limited to the teachings of any particular TQL expert or model. It looks at the squadron activity or process first and uses models and strategies which best fit the squadron. The Navy has officially adopted Deming's method and philosophy as the standard for TQL; however, this thesis does not limit itself to only his teachings.

3. Assumptions

This thesis is aimed at naval aircraft squadrons that are interested in the application of TQL in their environment. It is assumed that the reader already has a basic understanding of TQL, Deming's fourteen points, and the basic make-up of an organizational squadron.

For the purpose of simplicity, the term Total Quality Leadership will be used throughout the thesis. Total Quality Management and Continuous Process Improvement are different titles for essentially the same management philosophy as Total Quality Leadership. The term Navy and Naval Service used in this thesis includes the United States Marine Corps.

II. METHODOLOGY

A. LITERATURE REVIEW

An extensive review of current literature was conducted for information on the management aspects of Total Quality Leadership, as well as statistical tools for process control. A manual search of the Naval Postgraduate School library and the Reader's Guide to Periodical Literature yielded books and many current articles on work done on Total Quality Leadership in both the private sector and government institutions. The Defense Technical Information Center (DTIC) and Defense Logistics Studies Information Exchange (DLSIE) databases were also utilized.

The resources which proved to be the most useful were the DON TQL Senior Leadership Seminar instruction staff, the Naval Aviation Maintenance Office (NAMO), and the staff at the Navy Personnel Research and Development Center (NPRDC). They provided reading lists, case studies and course materials. Appendix A provides a list of readings the authors feel provide a broad and solid understanding of the Total Quality Leadership philosophy.

The Deming Library and *The Deming User's Manual* were also studied. They consist of twenty two video tapes and handbooks. Each of these tapes covers a separate area of

Total Quality Leadership according to Dr. W. Edward Deming. The Deming User's Manual presents the latest strategies for applying Dr. Demings' quality improvement methods in an organization. The tapes feature an impressive roster of management consultants. These experts teach practical application of his theories in manufacturing, service industries and government agencies.

The Naval Aviation Maintenance Office (NAMO) published a student handbook titled *Continuous Process Improvement (CPI) Graphical Tools Training Guide*. The handbook explains in detail several statistical tools and provides practice examples. This guide is a good resource to use for aid in understanding and learning statistical tools.

B. SENIOR LEADERSHIP SEMINAR

As part of our research we were able to attend the DON TQL Senior Leadership Seminar (SLS). The SLS was developed by the DON Executive Steering Committee and the Navy Personnel Research and Development Center to begin a top down TQL training process in the Navy and Marine Corps. The objective of the SLS is to provide senior leaders with the knowledge to begin to lead a total quality transformation.

The seminar is a four and one-half day class. The format includes lecture, class discussions, videos, and a team exercise on the last day. Evening reading is usually required in order to prepare for the next day's topic. A guest speaker is planned for each seminar and a member of the DON Executive Steering Group addresses each seminar.

The SLS technical review was completed in December, 1990 and the first class held in January of 1991. Since then, more than twenty classes have been completed training over 400 people. The primary location of the SLS is at the Naval Postgraduate School, Monterey, CA; some seminars have also been held in Washington, D.C. The current plan is to have two permanent locations -- Norfolk, VA and San Diego, CA.

The authors were allowed to attend the SLS as observers and participate in a group implementation plan. This opportunity gave us great insight on how the senior leaders of the Naval Service perceive the TQL philosophy and the direction it is going.

C. **PERSONAL INTERVIEWS**

After reading and studying literature and viewing the Deming Library tapes, informal personal interviews were held in order to collect data on perceptions, implementation strategies and perceived problems with the TQL philosophy as applied in the Navy. The following military officers were interviewed:

- LTGEN Walter Boomer, USMC
  Commanding General
  I Marine Expeditionary Force

- RADM John T. Hood, USN
  Aegis Program Manager

- Capt. Ernest L. Lewis, USN
  Commanding Officer
  Naval Training Systems Center

- Capt. Stephen H. Ries, USN
  Commanding Officer
  USS Trenton (LPD-14)

- LCDR Terri Merrit, USN
  TQL Facilitator
  CINCLANTFLT Quality Support Center

- RADM Lafayette F. Norton, USN
  Commander
  Fleet Air Caribbean

- Capt. Melville J. Walters, III, SC, USN
  Assistant for TQL
  Command in Chief U.S. Pacific Fleet

- CDR Paul K. Landers, USN
  Commanding Officer
  USS Baltimore (SSN-704)

These officers were chosen because of their seniority and position within the Naval Service. Their cumulative positions cover combat, surface and submarine ships, major staffs, ship building, weapons acquisition, and Total Quality Leadership facilitators. Each subject was in a different stage of TQL implementation. Although the interviews differed based on time constraints and their knowledge of Total Quality Leadership, the research questions posed in Chapter I were the basis for discussion.

Several civilian organizations which are involved in implementation of Total Quality Leadership were also interviewed. Interviews were held with the following people:

- Larry Walker
  Hewlett-Packard, San Jose, CA
- Kipp Lanman, Product Manager
  Intel Corp., San Jose, CA
- Jeff Whitaker, Industrial Engineer
  Kaiser-Permanente, San Jose, CA
- Bob DeCosta, Customer Operations Manager
  IBM, Monterey, CA

These interviews were also conducted with the research questions as the basis for discussion. Although the research questions are directed at an aircraft squadron, it was not difficult to mold them to fit the subject's environment.

The authors led two class discussions, at the Naval Postgraduate School, on Total Quality Leadership in the Navy as a whole and in an aircraft squadron. The class was a graduate level production class emphasizing Total Quality Leadership principles. The students were officers from the U.S. Navy, Army, Marine Corps and foreign military officers. The majority of the students were Aerospace Maintenance Duty officers and Naval Supply officers at the Lieutenant and Lieutenant Commander rank. Professor Dan Treitch[1] monitored the discussion. As with the personal interviews, the research questions were used as the basis for the discussion. These class discussions provided valuable information from the

[1] Associate Professor of Operations Management and Logistics, Department of Administrative Sciences, Naval Postgraduate School, Monterey CA.

Navy's middle management on preconceived ideas about TQL, possible roadblocks, and avenues for implementing TQL in fleet squadrons.

D. PERSONAL ANALYSIS

An important part of the research was combining the authors' experience and using it as an input into this thesis. The authors' background and experience complement each other in two areas, specific jobs and squadron types. The authors have held the following jobs in three different aircraft squadrons: Maintenance/Material Control Officer, Assistant Maintenance Officer, Quality Assurance Officer, Line Division Officer and Material Control Officer.

Our experience allowed us to discuss and examine the different aspects of a typical squadron environment. We questioned whether or not TQL would fit into the Navy, in particular an aviation squadron. Would it be just another program? Where would a squadron find time to implement TQL? What are the quality issues in squadrons? Can statistical tools be utilized in a squadron and if so what tools should be used? Based on these discussions we were able to differentiate between what can be attributed to particular squadron management style, and what is common to all carrier based squadrons. The results of these discussions were used in the development of this thesis.

The interviews gave us insight and knowledge of TQL activities outside the squadron and this enhanced our understanding of the Navy's senior leadership views and positions on TQL which might influence the squadron. The authors used the interviews as a sounding board to express ideas and receive criticism on the proposed applications of TQL in a squadron.

The information obtained from the preceding research methodology was used to develop the model in Chapter IV and the application of the fourteen points in Chapter V and the application of statistical tools in Chapter VI.

III. BACKGROUND

A. TOTAL QUALITY LEADERSHIP

1. Definition of Quality

The word "Quality" is used more and more each year. Advertisers exploit it, managers want to achieve it, and the populace want to buy it. Quality, of course, means different things to different people. The following definitions are some examples of how "Quality" is defined:

- "Quality is a distinctive characteristic, property, or attribute."(Random House Dictionary)
- "Quality is providing products services that meet the customers needs and expectations at a cost that represents the value to the customer."(The Users Manual)
- Quality control: according to the Japanese Industrial Standards (z8101-1981) definition, quality control is "a system of means to economically produce goods or services that satisfy customer requirements".(Imai,1986,pp.xxii)
- "Quality is anything that can be improved" (Imai,1986,pp.xxiii)
- "Quality consists of those product features which meet the needs of the customer and thereby provide product satisfaction."(Juran,1988,pp.2.2)
- "Quality consists of freedom from deficiencies" (Juran,1988,pp 2.2)

The word "quality" has multiple meanings, however there are three important factors which define quality. First, quality must be defined by the customer. Second, quality must be in terms that are measurable and objective.

Third, the supplier must understand the product, and why the specifications set define quality for the customer. What defines quality today does not necessarily define quality tomorrow. Customers' needs change, thus quality is dynamic. A supplier must continuously examine these factors in order provide quality now and in the future.

2. **Definition of a Process**

An important emphasis in TQL is process analysis. A "process" can be defined as the organization of people, procedures, machines and material into work activities needed to produce a specified end result. A process should have three characteristics: measurable input(s), value-added activities, measurable output(s), and repeatability. (IBM,1984,pp.5)

3. **Total Quality Leadership**

Total Quality Leadership is a philosophy of running an organization. It represents a completely new way of thinking about resources, processes, suppliers and most of all, customers. The traditional Naval management philosophy of, "Just get the job done!" or "Throw another body at it!" has fostered a style of muscling through a process, completing it, and calling it a success based only on the final outcome. Professor Rodney Minott[2] put it this way, "Unless the Navy

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[2] Former U.S. Ambassador to Sweden, Full Professor of History and International Relations, Senior Research Fellow, Hoover Institution, Naval Postgraduate School.

really bloodies their nose badly in a process, it has a tendency to keep repeating the same old steps." The Total Quality Leadership philosophy represents a fundamental clash with traditional Navy management philosophy.

Total Quality Leadership is a management philosophy which looks at processes in order to improve quality. You can not copy success; you must understand how something works then work to improve it. The implementation of TQL is not a simple adoption of a new program called TQL, it represents a culture change.

B. TOTAL QUALITY LEADERSHIP IN THE NAVY

1. History of TQL

The past decade has seen many American companies moving in the Total Quality direction. Most companies are doing it for the same reasons: high scrap and rework costs, recalls, customer complaints and most of all, competition that threatens the vitality of their businesses. (Strickland,1989,pp.1) The Department of Defense (DoD) is also moving in the same direction. On March 30, 1988, Secretary Carlucci signed a Department of Defense Posture statement on Quality. Total Quality Management was chosen because,

> Total Quality Management, with its operative concept of continuous process improvement, was selected as a proven management philosophy that was powerful enough and universal enough in scope to achieve the cultural change required for DoD to meet the unprecedented levels of

> quality required for future weapons systems and equipment. Total quality management seeks to marshal the creative energies and creativity of DoD and defense industry workers and to band them together in a drive for quality excellence. (Strickland, 1989, pp. 17-18)

The DoD goals are very similar to those of American companies; however the Department of Defence emphasis is on "the satisfied quality-equipped, quality-supported soldier, sailor, airman and marine," as stated by former Secretary Carlucci.

2. **Department of the Navy Executive Steering Group (ESG)**

The Navy's Executive Steering Group was chartered by Secretary of the Navy in 1988. The role of the ESG is to identify and prioritize strategic goals for quality improvement within the Navy and determine the overall DON vision, guiding principles, and goals in support of the Naval forces' mission. They are also charged with developing the education and training strategy. The DON ESG is chaired by the Under Secretary of the Navy and the original membership of consists of DON leaders in the following positions:

- Vice Chief of Naval Operations
- Assistant Commandant of the Marine Corps
- All Assistant Secretaries of the Navy
- Chief of Naval Personnel
- All Systems Commanders
- Chief of Naval Education and Training
- Commander, Military Sealift Command

- Surgeon General
- Commanding General, MCRDAC

The ESG meets monthly and does not allow members to have a substitute attend in their place.

The ESG's actions have included tasking the Navy Personnel Research Development Center with the development of the Senior Leadership Seminar class to begin the top down transformation. They also adopted the title Total Quality Leadership for the Navy's total quality philosophy. The title Total Quality Leadership was chosen because it illustrates the emphasis on leadership and the important role leadership will play in the transformation.

3. **Navy Personnel Research and Development Center**

The Navy Personnel Research and Development Center (NPRDC), has been deeply involved in the Navy's TQL efforts. NPRDC has been heavily involved with the Navy's TQM endeavors since the 1980s. In 1983, NPRDC was asked to conduct a TQM feasibility study for the then Chief of Naval Material. Following a positive recommendation, NPRDC assisted with the development of a pilot program at Naval Aviation Depot, North Island, CA. By 1985, the lessons learned at North Island began to be applied in other aviation depots.

NPRDC was then asked by the Department of the Navy's ESG via the Education and Training Quality Management Board

(QMB) to develop the TQM Implementer's seminar. The seminar has been held in San Diego since 1988.(Salvanera,1990,pp.18)

4. TQL Teams

The Executive Steering Group chartered the TQL teams through OP-01, the Naval Military Personnel Command, to directly serve the fleet in implementing TQL. There are two teams, one is located in San Diego, CA and the other in Norfolk, VA. The TQL teams report to their respective Commander in Chief. They are tasked with supporting local commands, chosen by the CNO, in the implementation of TQL through classes and direct consulting. The TQL teams act as consultants for the fleet units.

C. AN AVIATION SQUADRON

Carrier based squadrons are the backbone of Naval Aviation and provide a unique working environment for the officers and enlisted who serve in them. Carrier squadrons are very similar in most aspects, however, they do differ based on the type aircraft. Most aircraft carriers have seven squadrons which make up the Carrier Air Group (CAG). The CAG consists of one helicopter squadron, two F/A-18 squadrons, two F-14 squadrons, one A-6 squadron, one S-3 squadron, and one E-2 squadron. Each squadron is a separate entity both operationally and administratively.

A squadron, depending on the aircraft type, will have between 200 and 300 Officers and Enlisted personnel assigned.

The Officers, numbering between 15 and 30, represent several occupational specialties. There are usually two Intelligence Officers, two Aviation Maintenance Officers, a Limited Duty Officer, Ordinance Officer, Naval Pilots and Naval Flight Officers. The enlisted crew includes airmen, Petty Officers, and Chief Petty Officers. These men have specialties which include all aspects of the squadron from personnelmen and yeomen to aviation electriciansmate and aviation machinestmate. At the Petty Officer and above rank they are skilled technicians. Below the rank of Petty Officer they are considered apprentice.

The aircraft squadron uses a hierarchial organizational structure, see Figure 1. The Commanding Officer (CO) and Executive Officer (XO) are Commanders and are specially selected for command. The CO and XO hold their position for approximately 18 months, after which the XO succeeds the CO as Commanding Officer. The XO's position is filled from outside the squadron. The Command Master Chief (CMC) is normally the senior enlisted, he functions as the CO's principle advisor for enlisted affairs. The Department Heads are Lieutenant Commanders, the Division and Branch Officers are Lieutenants and below, with a Chief Petty Officer as an assistant, and the Work Centers are supervised by senior Petty Officers. Officers and enlisted are onboard approximately 36 months. During this time, they may hold several positions throughout the squadron.

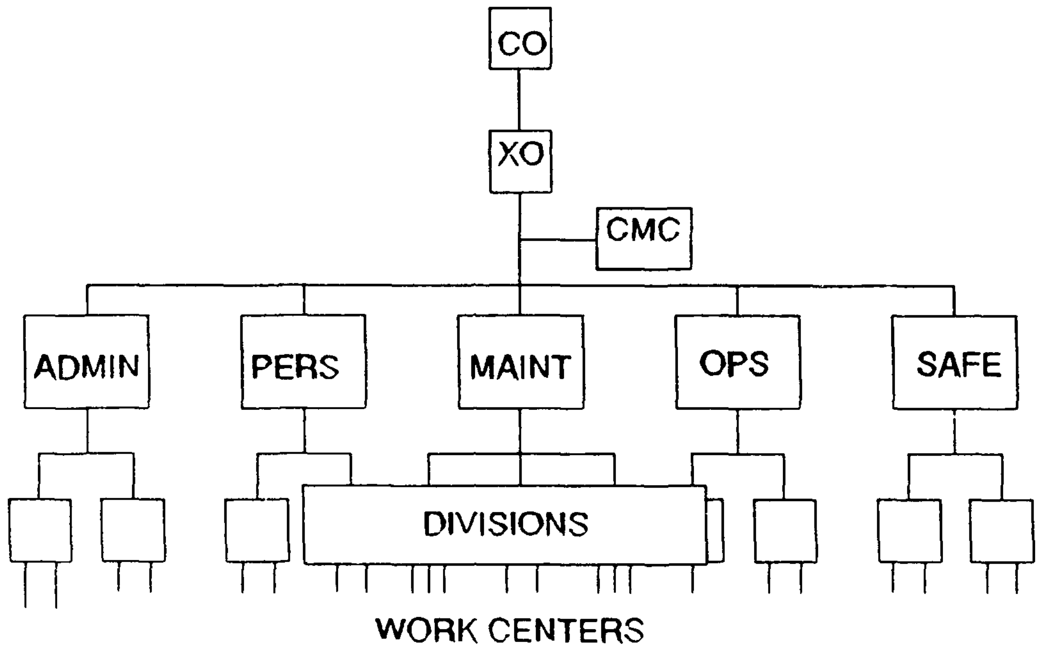

Figure 1 Squadron Organization

An aircraft squadron's deployment cycle is approximately 18 months long. The cycle commences at the completion of a deployment. It includes a short stand down period which is followed by squadron detachments and independent tasking. Six months prior to a major deployment the workup evolution begins. This workup evolution includes at sea operational periods, weapon exercises and intense training in preparation for deployment. The deployments usually last about six months, at which time the cycle starts over again. Personnel are transferred in and out of the squadron at any point during the cycle with the full manning level being at the beginning of the deployment.

IV. A TOTAL QUALITY LEADERSHIP SQUADRON MODEL

The Navy Personnel Research and Development Center developed a Total Quality Management Process Improvement Model designed to enhance the performance of naval industrial organizations through the application of total quality management principles and methods. The model describes a systematic method for improvement of an organization's products or services through analysis and correction of the processes that create them. The Total Quality Management Improvement Model is an adaption of the method developed by Shewart and Deming for process analysis and improvement. (NPRDC,1988,pp.v) The model was designed for use in large industrial manufacturing activities such as shipyards and naval aviation depots (NADEP).

This chapter modifies the Total Quality Management Improvement Model to fit the needs of an aircraft squadron. The interviews with senior military and civilian managers on TQL, the literature review, and our squadron backgrounds provide the information base for the development of the model. This chapter describes the Total Quality Leadership Model emphasizing four areas: organizational structure, Shewart cycle, customer/supplier relationships and mission deployment.

A. ORGANIZATIONAL STRUCTURE

The squadron structure, unlike that of a NADEP or shipyard, is relatively small and straightforward. There are typically five departments and four levels of management. The NPRDC TQM model is designed to facilitate cooperation and coordination between all the organizational command levels and functional departments. The squadron TQL structure overlaps the hierarchical structure and spans functional departments to form a matrix design. The objective of the overlapping structure is to bring together people from different functions and levels who can contribute perspective, data, and resources toward process improvement. This TQL structure consists of three levels: Executive Steering Committee, Quality Management Boards, and Process Action Teams. See Figure 2.

1. Executive Steering Committee

The Executive Steering Committee (ESC) represents the highest level of management in the organization. The ESC focuses on broad, general issues for organizational quality improvement efforts. The ESC identifies long term quality goals for the squadron and sets priorities. They interpret the squadron mission set forth by the Chief of Naval Operations. The ESC uses requirements from external customers (e.g., readiness or weapons efficiency from the carrier group) and from internal customers (e.g., condition of the barracks

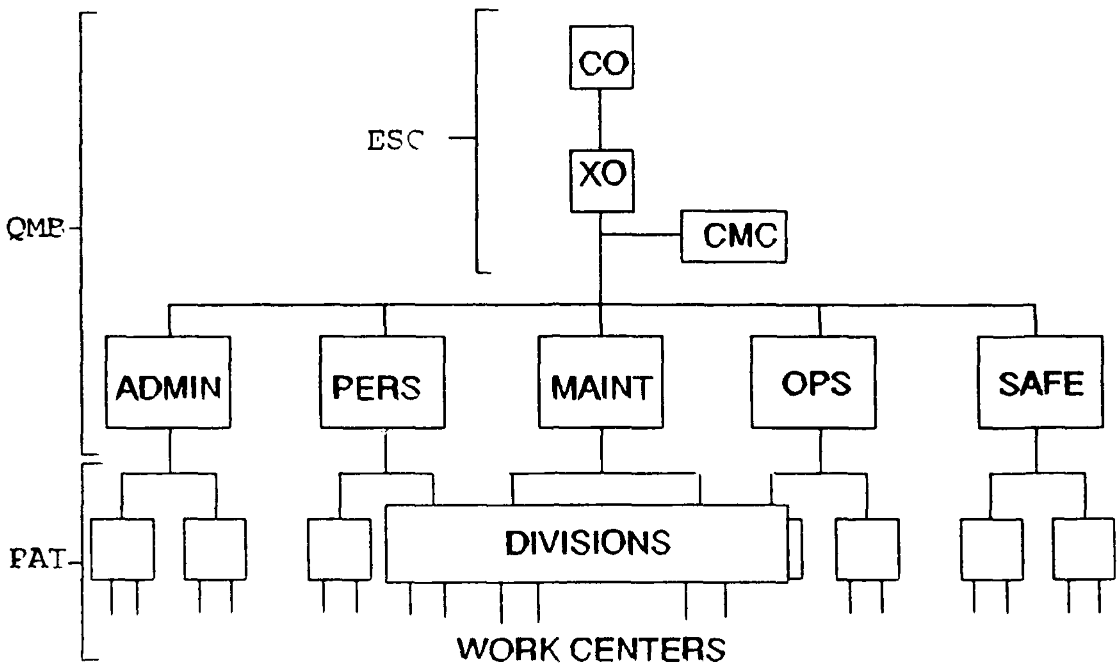

Figure 2 TQL Squadron Organization

from the enlisted personnel) to form long range mission plans or set of goals which will achieve the squadron mission.

The ESC in a squadron would include the commanding officer, executive officer, and the command master chief. The commanding officer is solely responsible for the squadron and the executive officer inherits the results of the CO's decision. In order to have a smooth transition from XO to CO, for the long term goals of the squadron, there must be a joint effort between the CO and XO. The third member of the ESC is the Command Master Chief (CMC). The Command Master Chief is the senior enlisted and represents the enlisted personnel in the squadron. The CMC would bring the needs of the crew to ESC and ensure the long term goals of the squadron were not in conflict with and are in the best interest of the enlisted. He also represents the enlisted in how they will contribute to the accomplishment of the squadron's goals. The ESC works with and is part of the Quality Management Board.

2. **Quality Management Board**

Quality Management Boards (QMB) are typically permanent cross-functional teams made up of top and mid-level managers who are jointly responsible for a specific product or service. (NPRDC, 1988, pp. 6) Most organizations using the Process Improvement Model would have several QMBs and the members of each team would have skills, experience, and ownership appropriate to a specific product or service. The objective of a QMB is to identify areas needing improvement in support of the goals set forth by the ESC.

The small size of a squadron and the cross functional experience of the senior members changes the make-up of a QMB. In a squadron there will only be one QMB and its members would include the ESC and the department heads. The department heads in a squadron (second level of management) will change jobs several times during the 2-3 year tour with that squadron. In most cases any department head is qualified to run any other department. Thus a single QMB would consist of managers who are jointly responsible for everything in the squadron and therefore have the knowledge and ability to relate the ESC's goals to specific outputs and processes.

Another justification for comprising the QMB of the department heads and the ESC is that squadrons hold "department head meetings" consisting of the CO, XO, Command Master Chief and department heads in which they plan for and solve problems. Keeping the membership of the department head meeting and the QMB the same allows for an easier transition into TQL by not having to create a new board or group and taking more time out for another meeting.

The QMB uses its combined experience to select areas of the squadron for quality improvement that will support the ESC's goals. The QMB will also organize temporary teams called Process Action Teams (PAT). These teams collect and analyze data about processes.

3. Process Action Teams

Process Action Teams are temporary teams comprised of people who are involved in the process being investigated by the QMB. In large organizations the members of the PAT are chosen by their respective managers on the QMB. In the squadron, the members of the PAT are chosen by the QMB board, but not necessarily by the respective department head.

A PAT may have membership from several departments or from only one department depending on the process involved and the discretion of the QMB. The Process Action Team will be composed of an advisor, who will be a member of the QMB, a team leader, and several team members.

The QMB member who is assigned as the PAT advisor provides a link between the PAT and the QMB. The PAT advisor communicates the target and problems identified by the ESC/OMB to the PAT and in turn communicates results, data collection, and appropriate recommendations regarding common causes to the QMB. As a rule the PAT advisor will not be the department head of the department in which the process falls. This policy reduces incentives for PAT advisors to influence PATs in their analysis of a process. It also decreases fear because the PAT team members are not reporting to their boss.

Each Process Action Team will have a team leader who is from the division level of management and at the Lieutenant or Chief rank. The team leader's responsibility is mainly to organize and lead the team. The team leader will be trained in running a team which includes meeting management techniques, group problem solving techniques (e.g., brainstorming), statistical tools, etc. He is the "process consultant" specifically trained to provide instruction in the analytic and problem solving methods associated within TQL.

As Lieutenants move from division to division within the squadron and collect experience leading different teams they will gain the skill and knowledge to be an effective QMB member at the Lieutenant Commander rank. The QMBs can control the effectiveness and the amount of respect the squadron in general has for these teams by selecting only the top people as team leaders. Doing this will make being a team leader a coveted position to be taken seriously.

4. TQL Coordinator

In the initial stages of transformation to the TQL philosophy, a TQL Coordinator may be necessary. This person should be a Lieutenant Commander fully trained in TQL techniques and possessing the knowledge base to assist in setting up the matrix organization. The TQL Coordinator will be involved in all functions of the squadron and at all levels of management. The rank of Lieutenant Commander provides credibility through experience and authority through rank. This is a temporary position designed to get TQL started. The TQL Coordinators' position is one of expertise in TQL not responsibility for TQL. The functions of the TQL coordinator become absorbed by other members of the squadron as the TQL philosophy and practices become a way of life.

B. THE SHEWART CYCLE

The matrix organization of the ESC, QMB and PATs overlaid across squadron functions gives management an avenue in productivity improvement. A process improvement approach known as the "Plan-Do-Check-Act" cycle provides a method in which management can achieve quality improvement. This approach was originally associated with the analytic work of Shewart, a colleague of Dr. Deming, and is called the Shewart cycle. See Figure 3.

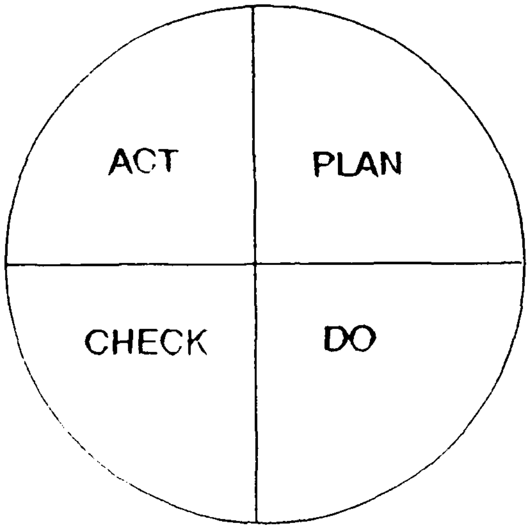

Figure 3 Shewart Cycle

In the Total Quality Management Process Improvement Model, management identifies important organizational goals during the "Plan" phase. Activities performed by the PAT in the "Do" and "Check" phases involve the identification and analysis of process variables that affect achievement of the goals. During the "Act" phase of the cycle, process corrections and improvements are made and evaluated by the QMB. Changes are formally installed and the process is monitored to maintain the improved performance. The cycle is repeated at the organizational level to pursue continuous improvement.(NPRDC,1988,pp.1) Each of the four components is described in more detail starting in section 2 below.

1. **The Bowman Cycle**

The Bowman Cycle[3] is a tongue-in-cheek representation of process management in a typical aviation squadron or any activity not yet familiar with the TQL philosophy. It provides a parody of the Shewart cycle while at the same time illustrating practices not uncommon in squadrons that have not yet adopted TQL strategies. As illustrated in Figure 4, the skipper or any manager receives filtered information, kills the people he hears it from, decides "if you want something done right you have to do it yourself" and micro-manages the workers involved in the process. This, of course, increases fear. The more fear the more filtered the information is and the cycle continues.

Although the Bowman cycle is an exaggeration it does illustrate an ineffective method of improving or even managing a process. The four activities in the Shewart cycle provide management with a structural approach to process improvement.

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[3] Real author unknown, adapted by Capt. Peter Bowman, U.S.N. (retired). Former DON Total Quality Leadership Seminar instructor.

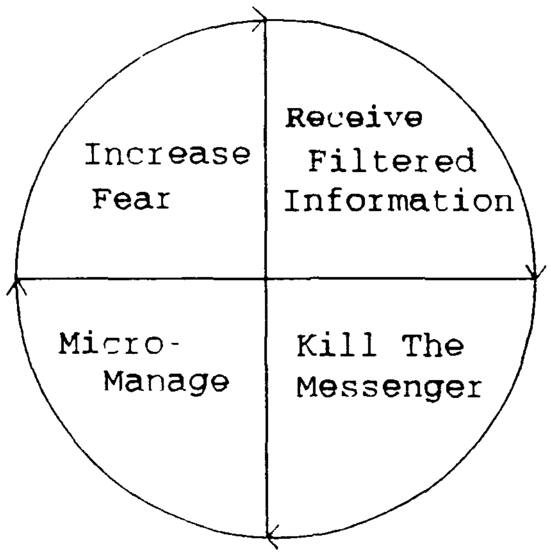

Figure 4 Bowman Cycle

2. The "Plan" Phase

The Executive Steering Committee identifies the critical product or service requirements of external customers. They work with the Quality Management Board to put these requirements into appropriate goals for the squadron. For example, COMNAVAIRLANT may require a specified aircraft readiness level -- the ESC and QMB would translate and break this requirement into specific goals for each part of the squadron. This action is the "Plan" phase.

The result of the "Plan" phase is a well developed plan with specific, measurable goals for the system and the process. The QMB is responsible for ensuring that appropriate goals are defined for all levels and functional groups of the organization and that their attainment provides a benefit to the customer.

3. The "Do" Phase

After the QMB and ESC have defined the goals and the responsible activities, a PAT is formed. The PAT proceeds based on the guidance and boundaries given to them by the QMB. The QMB identifies the process and the objectives of the PAT, this provides a constancy of purpose. This is not to be confused with micro-managing, the QMB must avoid the temptation of identifying a problem and telling the PAT "just fix it." The QMB must understand the process, the flow of the process and the attributes of the process. The PAT advisor and team leader select individuals who are involved in the activity to be investigated. The "Do" phase requires the PAT to do three things: study the current process and output to get a baseline, measure the values of those outputs, and identify an appropriate format for presenting the data.

The PAT must determine what parts of the process should be measured and how the output can be measured. As these variables are identified statistical experiments are conducted to study variation and determine the impact of these factors on the process. The PAT advisor and Team Leader ensure that the right statistical procedures and tools are chosen and used correctly to reflect the goals set by the QMB and ESC. Chapter VI explains, in detail, many of the statistical tools used in the "Do" phase.

4. The "Check" Phase

During the "Check" phase, the PAT team summarizes the information gathered in the "Do" phase for the QMB. The PAT team, through the PAT advisor, identifies the areas within the process that can be improved. The process may be impacted by different types of variables or "causes" within the system. Causes can be separated into two types, common or special. Common causes are a fixed part of the system such as procedures or types of tools and machinery. Common causes influence the performance of the system in a statistically predictable fashion.

Special causes are typically factors not part of the system or procedure such as a broken tool or power failure. Special causes do not influence the performance of the system in a statistically predictable fashion. (NPRDC, 1988, pp. 25)

5. The "Act" Phase

In this phase the QMB decides at what level of management the areas identified in the "Check" phase can be addressed. Typically, actions on special causes, those isolated and unpredictable process influences, should be dealt with at the work center level of management. Changing common causes, those areas that will change the total process performance, usually involve changes out of the workers' responsibility.(NPRDC,1988,pp.28)

For example, a FAT may investigate the length of time it takes the Line Division to turn an aircraft around after recovery. This process may include a person, with the proper training and tools, going to the aircraft, removing panels and servicing a system. After data collection and some statistical experiments in the "Do" and "Check" phases it is determined that special causes are a broken tool and the person arriving late to the flight deck after recovery. These special causes are not part of the system and can be addressed at the work center level. Other causes of variation such as the length of time it takes to remove a panel with a screw driver or the type of tool available for use are determined to be common causes. These causes are part of the system and influence the overall performance of the system. Substituting an electric hand drill for the screw driver would reduce the time required to remove the panel and decrease the overall time required to turn aircraft around. Although tool box configurations are a fixed part of the system and are determined at a higher level than the work center or squadron, it is the responsibility of the FAT to identify this to the QMB and ESC.

During the "Act" phase the QMB and ESC would determine the authority levels to make recommended changes and evaluate the changes in relation to the entire squadron. The nature of the change will determine how involved the ESC and QMB will be with the change. A change to the tool box configuration may require only approval, however changes such as the location the aircraft is parked or changing the panel fasteners from screws to latches would require more involvement from the QMB and ESC.

As the process is improved through the elimination of both common and special causes the responsible parties should document the new procedure and ensure squadron instructions reflect the new change. To keep the process from deteriorating, the critical area of the process must be monitored.

Although the PAT is dissolved at the completion of the cycle, the cycle on the squadron level still continues. The ESC is continually addressing new goals as the previous goals are met, the QMB is continuously forming new PATs to investigate different processes. At the lowest levels of the squadron, processes that have been investigated are continuously monitored in an effort to reduce variation and improve the process. These efforts form the continuous process improvement effort.

C. CUSTOMER/SUPPLIER RELATIONSHIPS

1. External vs. Internal Customers

As described above, quality is defined by the customer. But who is the customer? A customer is defined as anyone who is impacted by the product. Customers may be external or internal.

> External Customers. These are impacted by the product but are not members of the company which produces the product. External customers include clients who buy the product, government regulatory bodies, the public, etc. (Juran,1988,pp.2.2)

> Internal Customers. Within any company there are numerous situations in which dependents and persons supply products to each other. The recipients we often called "customers" despite the fact that they are not customers in the dictionary sense, i.e., they are not clients. (Juran,1988,pp.2.2)

The concept of the internal and external customer and their relevant importance is a topic subject to debate. Different organizations and even managers within the same organization will differ on the subject of the internal and external customer.

George Fisher, the CEO of Motorola, in a Harvard Business Review article entitled "Customers Drive a Technology-Driven Company" had this to say about internal and external customers:

> Everybody in this organization has to understand the customer much better. In fact, we've virtually outlawed the use of the word "customer" except to refer to the ultimate paying customer. For a while, people at Motorola thought they had "internal customers." They don't. There is only one customer -- the person who pays the bills. That's the person we're serving.(Fisher,1989,pp.39)

Another senior level manager at Motorola, Keki Bhote, who is the senior corporate consultant on quality, published an article entitled "Motorola's Long March to the Malcolm Baldridge National Quality Award" in which he says:

> Motorola's definition of "customer" has been greatly expanded to include the concept of Next Operation as Customer (NOAC). The external final customer is vitally important and always will be. But in a chain of operations to produce a product, information, or paper flow, there are many internal customer links. At each process step, there is a "process owner," an internal "customer" of that process, and an internal "supplier" to that process. The ultimate, external customer is better served if each internal customer is also served to the fullest. (Bhote, 1989, pp. 45)

And recently, at a conference entitled Quality Excellence Forum: Lessons from the Baldridge Award Winners, Bill Smith, vice president and senior quality manager at Motorola, said:

> You won't find a situation where you have very satisfied external customers where all of the internal customers are dissatisfied, and you won't find a case where you have very dissatisfied external customers, and all of the internal customers are very satisfied. (DeCosta, 1991)

Clearly the debate over the internal and external customer continues. The relationship between the customer and supplier, internally and externally, is fundamental to TQL.

All customers have needs to be met, and the product features should be indicative of those needs for both internal and external customers. In the case of external customers (e.g., Carrier Air Group staff, Supply Department, other squadrons in the CAG), a good customer supplier relationship determines customer satisfaction, and in consequence, squadron performance. In the case of internal customers, a good customer supplier relationship determines the squadron's competitiveness in productivity, quality and the state of morale among the internal departments and work centers.(Juran,1988,pp.2.3)

Customer and supplier relationships are foreign to most squadrons. In the initial stages of implementing TQL a squadron should concentrate on educating personnel in the identification of internal customers and suppliers, and the relationships involved. As an organization develops the internal customer-supplier relationships the same philosophy will also transfer to the relationship with external customers and suppliers.

Work centers, across all departments, are both internal and external customers. Aircraft maintenance evolutions pass from one work center to another in the maintenance department. Other processes, such as travel claims or payroll pass between work centers in separate departments.

2. The Nature of Customer Relationships

The relationship between customer and supplier ranges from adversarial to cooperative with many variations in between. In the adversarial relationship, the supplier is viewed with suspicion -- as someone who will try to sneak a bad product in or transfer more work onto the customer. In the cooperative relationship, the customer and supplier work together as if they were both part of the same organization. This is a planned, continued relationship based on mutual confidence, joint planning, mutual visits and assistance -- no secrets. This, of course, is the desired relationship.(Juran, 1988,pp.15.5)

The relationship between the work centers, where one is the supplier and one is the customer varies between adversarial and cooperative. The adversarial relationship is most prevalent in a squadron. This is due to the fact that the more work a work center can sneak to the next work center in the process, the customer, the less they have to do. Of course, another work center is trying to sneak more in to the first work center at the same time which perpetuates an adversarial relationship among all work centers.

For example, maintenance control often allows work centers to secure for the day when all their work is completed. This provides an incentive for a work center such as Power Plants to convince Maintenance Control that an engine problem is due to an electrical problem to be handled by the electronics work center. Of course the electronics work center will try to convince Maintenance Control that it is anything but an electrical problem. Consequently work centers spend a great deal of time pointing at each other instead of working together to solve a problem.

In the cooperative relationship, the customer and supplier work together as if they were in the same work center. This would require joint planning, mutual visits, assistance and an understanding of the other work center's process. A relationship of teamwork between internal customers and suppliers increases quality by enlightening the worker in the supplier work center in the effect his product has on the processes of the customer work center.

For example, the process of washing an aircraft is done by the line division. There are many customers of the wash job process. The most obvious customer would be the corrosion control work center. Aircraft washing is the first step in corrosion prevention and the corrosion work center can not find and treat corrosion on a dirty aircraft. In a teamwork relationship the corrosion control work center, the customer, would be involved in the line division's training, advising on soap types or supplies and even participating in wash jobs to understand their supplier's process.

The supplier, the line division, would get involved with the corrosion control work center in treating corrosion to gain a better understanding of the importance of this process. Clearly, a wash job done with the customer in mind will be of better quality than a wash job that is done because "somebody doesn't want dirty aircraft."

Customers' perceptions of quality will differ from those of the suppliers. Determining who the customer and suppliers are for different processes and translating their needs into a language everyone can understand will improve the quality of products and services between internal customers and suppliers.

3. Process Owners

Each process must have identifiable ownership. Sometimes it is unclear who owns a given process. In the wash job example, the line division is a process owner. However, the basic procedure and soap type for washing an aircraft are delineated in the technical manuals by the Department of the Navy or a higher level command such as the Naval Air Systems Command (NAVAIR). Thus, NAVAIR would own part of the process of the wash job.

A work center determining its suppliers and customers or a PAT team investigating a procedure must be aware of variables in a process the squadron does not own. For example, if the Line Division determines that the soap type is a critical variable in the washing process but only one soap type is allowed as per the Corrosion Control Manual, an investigation into different soaps may not be a good use of squadron resources. It would be very difficult for a squadron to determine environmental impacts, health effects and even the cleaning capabilities between different soaps. The PAT advisor and the QMB would help in determining those variables in processes that the squadron does not own and whether they should devote resources to investigate them. If, however, a problem is identified with a part of the process that is not owned by the squadron (e.g., soap type), this should be communicated, with relevant data and recommendations, up the chain of command.

There are several programs available to a squadron which allow and motivate squadron personnel to challenge procedures and techniques which they otherwise would have no control over. One such program is the Military Cash Awards Program (MILCAP). The objectives of MILCAP are to:

- Encourage military personnel to suggest practical ways to reduce costs and improve productivity in the Navy, DoD and other Federal government operations.

- Provide [a] formal channel for communications between management and personnel.

- Maintain working conditions where imagination, creativity, and innovation are encouraged. (Chief of Naval Operations, 1988)

The Model Installation Extension Program (MIEP) is a program designed to help organizations make changes outside of their control. Under the MIEP, request for waivers:

- Can be used to request relief from any policy, regulation or law which stands in the way of implementing an innovative idea.

- Can be used by installation commanders to obtain freedom in purchasing goods and services wherever they can get the combination of quality, responsiveness, and cost that best satisfies their requirements. If appropriate, constraining laws or federal regulations may also be the subject of waiver requests. (Chief of Naval Operations, 1987, pp. 7-44)

As process owners both internal and external to the squadron, increase their understanding of the interdependence of operations, fleet requirements, base policies and change procedures the quality of performance and readiness of the squadron will be enhanced. The programs listed above provide an avenue to squadrons to influence processes owned by external commands.

D. MISSION DEPLOYMENT

This section will discuss and give some examples of squadron missions, define mission deployment and its relevance to TQL, and discuss the deployment of the mission throughout the squadron.

1. The Squadron Mission

The squadron mission is developed by the office of the Chief of Naval Operations. Several factors are taken into developing the mission, primarily the nature of the threat and the capabilities of the aircraft. Based on the mission, the squadron's assets are fixed. These assets include manning levels, training, support equipment, flying hours, monev and practically everything else the squadron owns. Most squadrons of a particular aircraft type are assigned the same mission. However, the mission can be tailored to individual squadrons; for example, an S-3 squadron which also does inflight refueling will have a slightly different mission than an S-3 squadron that does not. The squadron with the refueling mission will be manned with personnel capable of working on the refueling equipment and flight hours will be assigned to perform the mission.

The squadron mission is promulgated in the OPNAV C3501.2H instruction also known as the ROC (Required

Operational Commitment) and POE (Projected Operational Environment). The ROC and POE give the mission and specify what the squadron is required to have to perform that mission. The following are examples of squadron missions.

- Medium Attack A-6E Mission: Provide offensive air to surface attack operations and subsurface offensive and defensive mining operations, provide the carrier battle group long range day and night all weather strike capability against land based and sea borne targets.

- Early Warning E-2C Mission: Provide carrier airborne early warning, surveillance command, communication and control, battle management and over the horizon targeting capability in support of Navy and Marine Corps operations both afloat and ashore.

- Fleet Replacement E-2C and C-2 Mission: Indoctrinate and train naval aviators, naval flight officers, aircrewmen and maintenance personnel in the operations and maintenance of carrier airborne early warning and carrier logistics support aircraft and their systems in order to provide a maximum level of air combat readiness in fleet airborne early warning and fleet logistics support squadrons.

The missions do not change very often and are not commonly known at the squadron level. In our effort to determine the mission of certain squadrons we telephoned several squadrons. Although they knew the capabilities of their aircraft, they did not know the mission of the squadron and referred us to the wing. The wing also did not know and referred us to the aircraft type project manager, OP-501, in Washington, D.C. This office provided us with the mission of the squadron for that type of aircraft. The process of determining squadron missions included calling four to five squadrons, the wing, and then the project office. This process was done for three different aircraft type squadrons. Only one squadron, a fleet replacement squadron, knew the mission of their squadron.

A squadron, in a TQL environment, must know the mission, develop a mission plan for all levels of the organization to accomplish that mission, and deploy the mission plan throughout the squadron.

2. Mission Deployment as a Part of TQL

Mission deployment is a management process to help the squadron achieve improvement objectives that support the squadron mission. It is also a method to get everyone, from the Skipper to the most junior airman, involved in supporting the mission. The process focuses the many resources of the squadron on a few high priority issues to achieve success.(Florida Power and Light,1989,pp.3)

The mission of the squadron must be understood at all levels of the squadron in order to improve quality. The QMB and PATs must understand how operational processes affect the mission of the squadron in order to determine which processes need improvement and how much and which resources to invest in the improvement effort.

Through Mission Deployment the airman apprentice in a work center will know how his job of washing an aircraft or properly documenting his man hours contributes to the squadron mission. He will also become aware, through mission deployment, that improving the processes for which he is responsible will enhance the ability of the squadron to accomplish the overall mission.

Deploying the mission throughout the squadron is a continuous process involving all levels of the squadron. The Mission Deployment Flow chart, Figure 5, provides a graphical explanation of the process.

The ESC interprets the mission from DON with guidance from the Carrier Air Group Commander, Wing Commander and other external customers. This guidance provides consistency among squadrons. They use these inputs and inputs from squadron members to develop a mission plan or set of goals which will achieve the squadron mission. The mission plan or goals is a road map which will lead to the accomplishment of the mission. The mission plan can take several forms depending on the discretion of the ESC. The mission plan can be a narrative or outline of subjects or topics to best achieve the mission. As the squadron's strengths and weaknesses change, the mission plan is updated to reflect these changes.

The elements of a mission plan will usually be cross-functional. The QMB matches processes with the mission plan and sends it down to the work center level. For example, providing communication and control is part of the Early Warning E-2C mission (VAW) mission, and the ESC may determine increased rate training is an avenue to take. Increasing the rate training process will cross several departments:

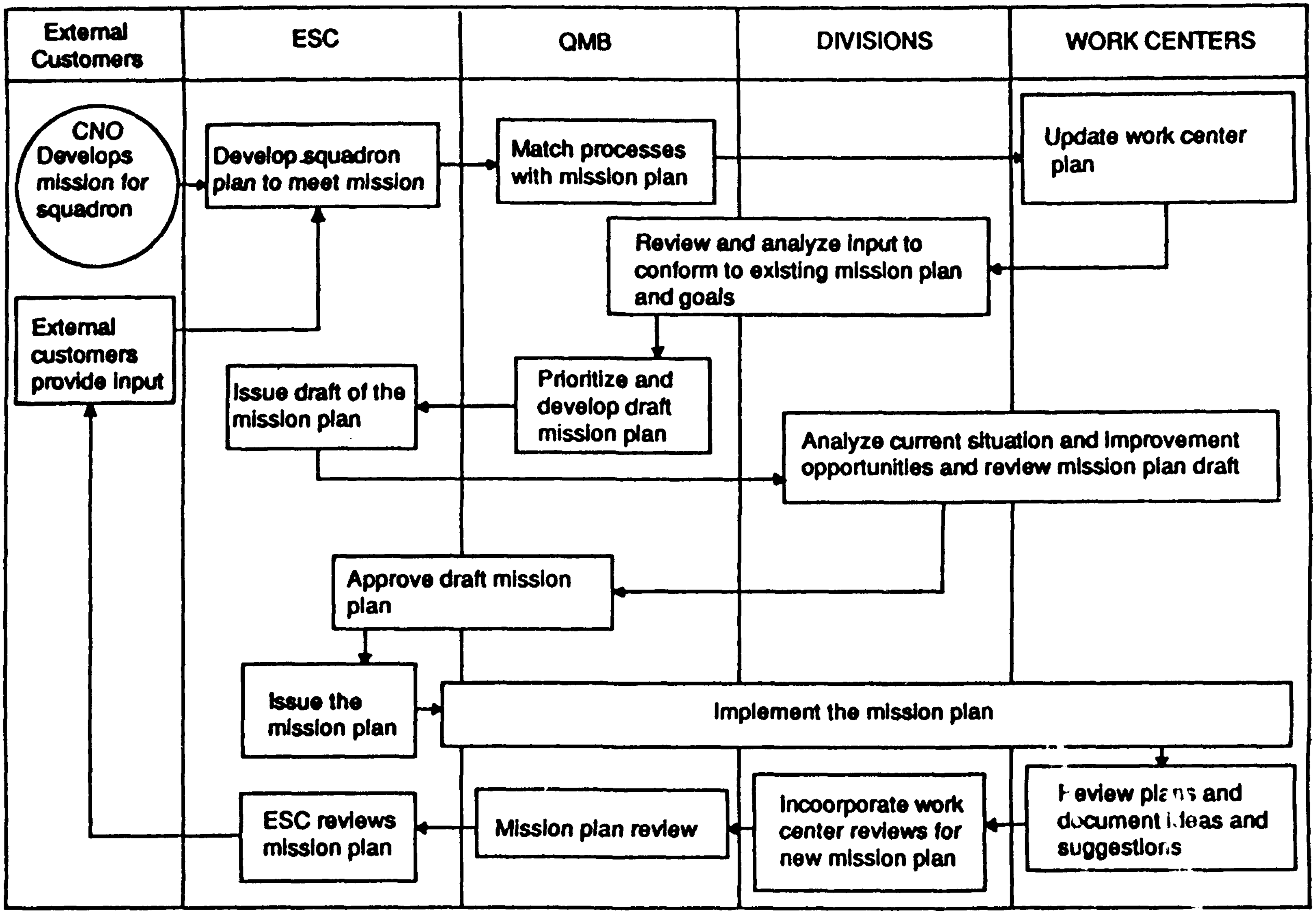

Figure 5 Mission Deployment Flow Chart

personnel department would order training manuals, maintenance department would determine which rates to train, and operations may have to be involved if a program such as IWSR (Integrated Weapons System Review) is used. The QMB determines which processes are involved and which work centers own them.

The work centers review the current plan and provide input back to the QMB on implementing the plan. The QMB uses the inputs from the work centers and the new mission plan from the ESC to prioritize and develop the draft mission plan.

The ESC issues the draft mission plan to the division and work centers. The draft mission plan is reviewed and sent back to the ESC. The ESC approves the draft mission plan and it becomes the official mission plan. The divisions and work centers implement the mission plan.

As the mission plan is carried out, work centers document ideas and suggestions which are passed up through the division to the QMB. The QMB reviews the mission plan using the inputs from the divisions and work centers and passes the review to the ESC. The ESC, using the mission plan review from the QMB and input from external customers, develops a new squadron mission plan. The process continues.

The continuous improvement process philosophy of TQL should be an integral part of every facet of the squadron. Using the mission deployment flow chart, continuous improvement becomes a way of doing business day to day. Every member of the squadron is always looking at the process and how its improvement will affect the mission of the squadron.

V. APPLICATION OF DEMING'S 14 POINTS

A. OBJECTIVE AND PURPOSE

The purpose of this chapter is to present Deming's 14 points and how each point can be applied within an aviation squadron. The objective of this chapter is to reduce the roadblocks to using the 14 points in implementing TQL.

The 14 points reflect Dr. Deming's years of experience with management in implementing quality efforts. The 14 points are the basis for the quality transformation of industry. They represent a system by which all of the points must be implemented in order for the transformation to occur. They provide an outline of the obligations of top management and provide a yardstick by which anyone in the squadron may measure the performance of the squadron. (Deming,1982,pp.1-7)

A common criticism of Deming's 14 points is that they may work for private industry they don't apply to the Navy, or more particularly to a squadron. However, the 14 points are a philosophy -- not a prescription. They are designed to stimulate thought. Different organizations have their own interpretation of what the 14 points mean or how they can be applied.

The 14 points should be presented to a squadron in their original form to promote thought and discussion on how they can be applied. This chapter provides ideas for discussion on how or if they can be applied to an aviation squadron. The 14 points were taken from the Deming Library Tapes. Which provide an easy to understand presentation in comparison with the written, "Out of the Crisis". (Deming,1982)

B. DEMING'S 14 POINTS

1. Point 1

"Create and publish to all employees a statement of the aims and purpose of the company or other organization. The management must demonstrate constantly their commitment to this statement."

Constancy of purpose for an aviation squadron is spelled out clearly in the squadron's mission. Whether it is putting bombs on target or battle management, each squadron must publish the mission of the squadron. The loop in the Mission Deployment Flow Chart between the squadron ESC and the CAG/Wing provides a consistency of purpose between like squadrons and squadrons in the same CAG. It allows all squadron members of be fully aware of how their day-to-day responsibilities contribute to the accomplishment of the mission. The mission deployment process provides a method to publish the aims and purpose of the squadron and allows all squadron members an input to the process. The continual update of the mission plans demonstrates management's commitment to the mission.

2. **Point 2**

"Learn the new philosophy, top management and everybody."

The end of the cold war has brought a new era of declining budgets and resources to which Naval Aviation must now adjust. Old management structures and philosophies, which worked well during the military build up of the eighties, will not work in this new era. The Navy will face these new and different challenges in the next decade.

Quality must become a way of life in the Navy in order to meet the new challenges. TQL must be viewed as a transformation of philosophy within the Navy and squadrons; it must not be viewed as a program nor be implemented as a program. The technical growth of the Navy is such that management must increase their resources in solving problems and improving quality. A major under utilized resource is the airman in the trench. TQL provides an avenue for this airman to pass ideas up the chain of command.

3. **Point 3**

"Understand the purpose of inspection, for improvement of processes and reduction of cost."

Deming modified this point from "cease dependence on mass inspection". The key to this point is to <u>understand</u> (knowledge) the purpose of inspection. In the aviation community, inspections are an important part of daily operations. In a squadron 100% inspection on certain maintenance evolutions is necessary for reasons of safety. Deming does not argue against inspecting for safety, only against inspecting for quality. Quality must come from improving the process not from inspecting. Even 100% inspection does not assure quality. A job that has to be reworked several times is not a quality job even though it passes inspection on the third time.

Inspecting less does not take the place of high quality standards. And failing inspections does not always reflect lack of attention to quality. An increase in quality and the quantity of inspections are independent. According to Deming, as process improvements lead to increases in quality, the need for inspections decreases. A squadron using TQL will experience a decrease in the amount of rework required as a result of an increase in quality. However the quantity of inspections will remain due to the life critical nature of tasks and processes.

Managers must have the knowledge of the process and understand what action to take based on the best information at hand. Inspection is a form of "Check" in the PDCA cycle; but before action is taken, the purpose of the inspection must be understood and information regarding failed inspections must be gathered. For example, when a work center fails a zone inspection, study the process. It may be because there was no effort put into preparing for the zone inspection, but, it may be because the shop spent all night on a hard repair job.

4. Point 4

"End the practice of awarding business on the basis of price tag alone."

Unlike most commercial organizations, a squadron does not typically purchase goods and services from vendors. However, a squadron must manage its resources and these resources must not be used based on price tag alone.

Navy organizations, especially squadrons, use labor intensive tasks as a major part of doing business (e.g., watches and working parties). A common way to solve a problem in a squadron is to "throw another body at it." This is a perfect example of using resources based on the price tag alone. Given the absence of internal accounting systems the sailor is "free" to the squadron, but not in terms of the over all DON, DoD, or U.S. budget. The squadron does not pay military personnel out of its budget and the sailor gets paid the same amount whether he works 40 hours or 80 hours. Based solely on price tag the sailor is a very cheap resource. However, using this method does have its costs and organizational inefficiencies when this resource might be used in another capacity, thus increasing overall organizational capabilities. It also breeds discontent among the crew and leads to poor morale, and low motivation. Being treated as an expendable commodity encourages personnel to work at a level that just gets the job done -- right, wrong or otherwise.

Squadrons considering quality in the allocation of their human resources will consider total cost. The short term consequences of a decision may be increased productivity but the long term or total cost may be decreased retention, morale, and quality.

5. **Point 5**

> "Improve constantly and forever the system of production and service."

The Navy has always had the philosophy of improvement. Individuals are always walking into a new job and improving it. Not a Report on the Fitness of Officers (FitRep) or Enlisted Evaluation (Eval) goes by that doesn't say that the individual improved something. Yet, their predecessor made the same improvement. If this improvement was made earlier then why is it so fouled up again? The problem is not that things get fouled up again and need improvement but it is the type of improvement or change that is made. Many of the changes that occur are not based on data compiled by a thorough analysis of the process. Often changes are made by a newly commissioned officer intended in demonstrating authority or based on an immediate symptom rather than the real cause. We in the Navy are good problem solvers, but we don't concentrate on improving the process. We treat the symptom not the cause. We're fire fighters. If we stomp out the fire, we live another day. When the fire fighter leaves, the fire rekindles! If the squadron is improving the process then why the cyclical performance of squadrons? Deming:

> "Putting out fires is not improvement of the process. Neither is discovering and removal of a special cause dedicated by a point out of control. This only puts the process back to where it should have been in the first place."(Deming,1986,pp.50)

6. Point 6

"Institute training (for skills)."

Training for skills and process improvement will be instrumental to the successful implementation of TQL. The Navy is attempting a cultural change in problem solving techniques. The change can only be successful through training. From the squadron Commanding Officer to the new airman, everyone in the squadron must receive process improvement training. Training must be viewed as a process in and of itself within an organization. Under the current economic constraints we must train more not less, only through training can we prevent costly errors. Everyone in the squadron must know how to do their job.

The aviation community has made some improvements in training. The Personal Qualification Standard (PQS) has been eliminated and programs such as Maintenance Training Improvement Program (MTIP) have been adopted. However, there are two areas which need further investigation: the number of requirements and the method of training. The training requirements and the activities that create them should be examined. The majority of the training requirements come from outside the squadron, these activities require training without regard to the capability or need of the squadron. For example, the squadron is required, by the station safety department, to give hazardous material training. A lesson guide, which is read at some periodical interval, is all that is provided. A hazardous material seminar taught by an expert in this area would provide a much better medium for training than reading a lesson guide. A method of measuring the benefits of hazardous material training should be developed to determine the frequency and depth of training.

The second issue, method of training, also merits a quality check. The squadron has many talented men but they are not in the business of training. Our current training method is worker teaching worker. In a squadron, training sometimes degenerates to resemble the game you played when you were a kid. The first kid in line tells the second a phrase and by the time it gets to the end, it is no where near like when it started. The effectiveness of this approach, in contrast with the use of professional trainers, merits study.

7. **Point 7**

"Teach and institute leadership."

Traditionally, leadership has been an integral part of the Navy. This point will not be a roadblock for implementing

TQL within a squadron. The goal of leadership is to help people do a better job; leaders identify and remove barriers that prevent workers from doing quality work.

> The aim of leadership should be to improve the performance of man and machine, to improve quality, to increase output and simultaneously to bring pride of workmanship to people. Put in a negative way, the aim of leadership is not to find and record failures of men, but to remove the causes of failure: to help people do a better job with less effort. (Deming, 1986, pp. 248)

8. Point 8

"Drive out fear. Create trust. Create a climate for innovation."

Fear in this context is the fear a sailor has of suggesting new ideas or communicating problems. But as a result of this fear, there is diminished innovation and lost opportunities for improved quality. Reducing fear is not to be confused with circumventing the chain of command or questioning the respect due to superiors.

The squadron is more conducive to fear than a civilian organization. Squadron management has direct and immediate control over subordinates through non-judicial punishment and the highly disciplinary culture of the military. This, combined with the frequent requirement of one way communication in the promulgation of orders can create an environment which fosters fear. The squadron must provide an open environment for ideas to be heard and a mechanism for problem solving.

9. **Point 9**

"Optimize toward the aims and purposes of the company the efforts of teams, groups, staff areas, too."

Teamwork is an important component of the Navy. In order to achieve teamwork we must break down barriers within and outside the squadron. Work centers must work together, not against each other. Sister squadrons must not compete against one another at the expense of the mission. The aim of the system is cooperation through communication, both vertical and horizontal. The establishment of cross-functional PATs and a QMB will encourage team work and communication. The linkage through the PAT advisors, and the explicit response of senior teams, will facilitate the achievement of PAT activities to improve quality. The squadron's understanding of customer-supplier concepts will help to break down barriers.

10. **Point 10**

"Eliminate exhortations for the work force."

The requirement to post posters may create more harm than good. Slogans do not help people do the job better. "Think safety", "Do it right the first time", "A job isn't worth doing unless its done right", are examples of slogans that don't give the sailor a means to an end. They place the blame on the worker which is demotivating and generates frustration and creates resentment. Don't underestimate the intelligence of a sailor; he/she wants to do a good job but it's frequently management's lack of awareness of barriers that prevent him from doing so.

Posters that explain how the squadron is doing month to month in improving processes boost morale. Public acknowledgement of achievements will not only provide recognition, but will motivate and model continuous improvements.

11. Point 11

> (a) "Eliminate numerical quotas for production. Instead, learn and institute methods for improvement."
>
> (b) "Eliminate M.B.O. (management by objective). Instead, learn the capabilities of processes, and how to improve them."

Numerical goals and quotas have a negative effect on the squadron when they are not accompanied with a means to accomplish the end. If a process is under statistical control then it can be predicted and there is no need for a goal -- you will get what the system can deliver. A goal beyond the capability of the system will not be reached.

> Goals are necessary for you and for me, but numerical goals set for other people, without a road map to reach the goal have the effect opposite to the effects sought. (Deming, 1982, pp. 76)

Numerical goals are common within a squadron. For example, goals for retention, Full Mission Capable (FMC) rate, Combined Federal Campaign (CFC) participation, and the expenditure of resources. Management by these numerical goals is an attempt to manage without knowledge of what to do, and in fact is usually management by fear. The process based statistical procedures suggested by TQL provide an objective basis for performance expectations in contrast with goals that are arbitrarily chosen (e.g., CFC participation will be 100%, rating exam participation will be 100%, or FMC rate will be no less than 80%)

The only numbers that are permissible for a manager to dangle in front of the squadron is a plain statement of fact; e.g., maintenance must have four FMC aircraft to meet tomorrow's mission. (Deming, 1982, pp.76)

12. Point 12

"Remove barriers that rob people of pride of workmanship."

Compared to the commercial world, the squadron has a much easier job in developing pride in workmanship. Navy pride, patriotism, and squadron unity make it easy to motivate the troops around a common cause. The squadrons that are successful accomplish this through squadron patches, names on aircraft and the social environment.

The Enlisted Evaluation and the Report on the Fitness of Officers reporting and ranking system needs to be investigated. They create barriers which rob people of their pride and willingness to contribute to the group effort.

The ranking system that puts individuals against each other does not support total quality performance of the total organization. To date there are no good substitutes for the fitreps and evals that provide the information necessary to assure the promotion of the best people. And indeed, changes in these procedures may be beyond the squadron's control. However, in line with TQL, the evaluation process should be a continuous process to improve the performance of the worker based on criteria not normative standards. As currently implemented, Evaluations and Fitness Reports function as a form of inspection at the completion of the process or evaluation period.

13. Point 13

"Encourage education and self-improvement for everyone."

The Navy needs not just good people; it needs people that are educated and prepared for changes in process and technology. Because of the dynamic and ever changing environment in which we work, we often rely on the security of well-known standard practices. Yet these same practices may be ineffective to deal with the dynamics of the situation. In addition, these practices become locked in concrete and ingrained within our culture and are therefore difficult to change. Educating people activates the mind and innovation arises from active minds. With the current fiscal constraints, we must consider education as an investment not an expense.

There are numerous educational opportunities available to the squadron. Navy Campus provides educational assistance for programs such as PACE, Boost, NROTC, Veterans Assistance, and the GI Bill. These programs need to be promoted and made accessible for individuals in the squadron. This can be assisted through counseling and/or consideration on the watch bill and work shifts.

14. Point 14

"Take action to accomplish the transformation."

The above 13 points are difficult to adapt to the squadron, but they must be implemented into the squadron's plan for quality improvement. The mission deployment flow chart, the Shewhart Cycle, Continuous Process Improvement tools, and the Squadron Model, mentioned herein, are actions toward the accomplishment of the transformation. They are a means to get everyone involved by developing a critical mass.

VI. APPLICATION OF CONTINUOUS PROCESS IMPROVEMENT TOOLS

This chapter discusses the application of Continuous Process Improvement (CPI) graphical techniques/tools within an aviation squadron. One of the key elements of the TQL philosophy is the use of graphical techniques to analyze problems and processes which have been targeted for improvement. We approached this chapter as if we were a PAT charged by the QMB to determine how CPI can be applied to a squadron. The target, apply CPI tools, was set by the QMB in the "Plan" phase of the PDCA cycle. The tools are used primarily by the PAT in the "Do" and "Check" phase of the PDCA cycle. The purpose here is to present examples of how the CPI tools could be utilized in the analysis of squadron operations. Appendix B lists most of the CPI tools; only the most common ones are elaborated in this chapter, the *Process Control Capability and Improvement* book by IBM is a good reference for understanding CPI tools. The examples were compiled from actual and fictitious data in order to convey the principles of each tool.

The tools can be categorized into <u>problem</u> and <u>process</u> analysis tools. Both have their own unique features and must be used together to get the full picture of a process and where improvements are likely to be made. Problem analysis tools are used in the "Do" phase and include: Cause-and-

Effect diagram, Pareto chart, and the Scatter diagram. Process analysis tools are used in the "Check" phase and include: Run chart, Control chart, and Histogram. The Flow diagram can be used in either category.

There is a common confusion in the terminology of CPI tools. Statistical methods include the use of the histogram, Pareto diagram, scatter diagram, run charts, and control chart. Statistical Process Control (SPC) refers specifically to control charts, but the terminology is often used in reference to all statistical methods.

The initial challenge we faced in beginning the process analysis of this chapter was in determining the squadron's all encompassing purpose. We were looking for a single attribute that could be measured and would indicate how well a squadron was doing. We chose as the indicator of squadron effectiveness -- the Full Mission Capable (FMC)[4] rate. However, as will be described in the cause-and-effect analysis below, it later became clear that the FMC rate was not an indicator of effectiveness. Initially, the FMC rate is not a good indicator as the cause-and-effect analysis discusses below. The FMC rate was selected because every squadron

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[4] Full Mission Capable (FMC) rate - Refers to the percentage of squadron aircraft that are FMC (all aircraft systems up and working) in a squadron, usually calculated monthly.

$$\text{FMC} = \text{number of a/c in a squadron} \times \frac{\text{number of hours a/c up}}{\text{number of hours available}}$$

measures it, and secondly, because it is used in determining rewards. The principles of TQL when applied to the squadron would suggest an analysis of all processes contributing to FMC rate. This initial problem analysis is best addressed by a cause-and-effect diagram which analyzes all the processes involved in contributing to the FMC rate. The development of this diagram is presented below.

A. CAUSE-AND-EFFECT DIAGRAM

1. Description of Cause-and-Effect Diagram

The cause-and-effect diagram (also known as the Ishikawa diagram or the fishbone diagram) was developed in 1950 by Professor Kaoru Ishikawa. (Juran, 1988, pp. 22.37) It was developed to show the relationship between some fail point or desired "effect" and all possible causes which have an influence on that effect. (NAMO, 1990, sec. 6) The purpose of conducting the cause-and-effect analysis is to identify the variables that appear to have a major influence on the process results. Once these variables or potential "causes" have been identified, they can be analyzed using a Statistical Process Control (SPC) graph such as a scatter diagram. This SPC analysis is conducted in order to verify that the "causes" significantly affect the process performance. The variables identified during the cause-and-effect analysis are also studied (e.g., plotted on run diagrams and control charts to isolate out-of-control factors) to determine the type of influence these variables have on process results. (NPRDC, 1988, pp.13)

To create a cause-and-effect diagram, (see Figure 6), the effect (symptom) is written at the head of the arrow. (Juran, 1988, pp.22.37) Potential causes (theories) or contributing factors are then added to complete the diagram with main quality characteristics serving as the spine bone. Primary bones connecting to the spine are major categories. Secondary and tertiary bones represent factors (variables) or processes that contribute to that quality characteristic within the major category. (Schonberger, 1991, pp.665) A common set of major categories (primary bone) of contributing factors include personnel (manpower), work methods, materials, equipment (machinery), environment, and measurement.

Fishbone diagrams must be produced by the people who know the process. If solutions are not found in the first diagram more in depth fishboning maybe required. Some factors can be measured numerically, some may be too non-specific or out of the realm of concern. The PAT team may determine that only a few of the problem causes merit data collection (action) using control charts or scatter diagrams. It is important to note that most process improvement does not involve formal measurement and statistical analysis; a flow chart or brainstorming session maybe all that is needed. The process improvement may result from getting the key individuals together to understand and improve the customer

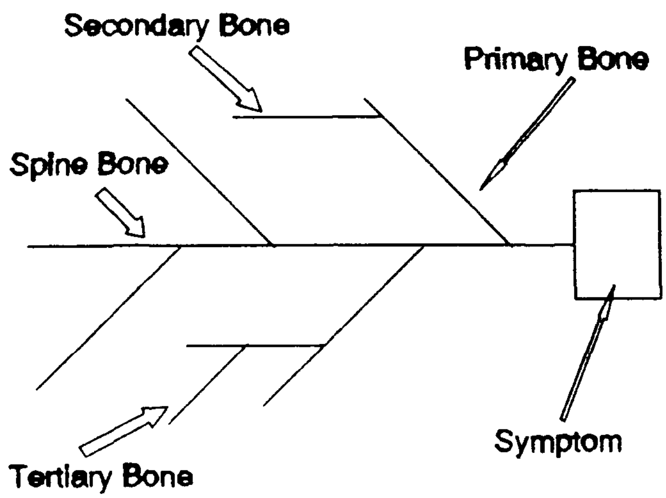

Figure 6 Cause-and-Effect Example

supplier relationship.

Some organizations use the cause-and-effect diagrams to continually collect and display information on the important variables in a process or to transmit knowledge about a process to all workers. (Juran, 1988, pp. 16.9) The diagram is posted and as more experience is gained on the process, the cause-and-effect diagram is updated.

2. Performing Cause-and-Effect Analysis

We encountered several problems in the development of the cause-and-effect diagram. The range of problems went from deciding the main symptom and major categories to determining the individual factors and their location in relationship to the major categories.

The first step in the development of the cause-and-effect diagram was to decide the all encompassing main effect, outcome, or mission of a squadron. Initially we choose FMC rate as the main effect of a squadron. Through brainstorming and several false starts during the cause-and-effect analysis we decided that FMC rate did not include all the processes within a squadron; it was only a measurement.

We wanted a cause-and-effect diagram that would include all the processes/variables that influence a squadron. This could then be used as a reference in the development of specific process cause-and-effect diagrams and for the application of CPI tools. We determined that Readiness, not FMC was a more all encompassing outcome of a squadron. All processes that occur within a squadron effect Readiness. Readiness can be measured in a number of different ways. For example Readiness may be the squadron's effectiveness in fighting fires, damage control, maintenance trouble shooting, or the number of ready (up) aircraft. Determining the processes that contribute to each of these aspects of readiness is the essence of cause-and-effect analysis.

The next step was to determine the major categories. As will be typical of a PAT comprised of different individuals with different perspectives, experiences, and biases, our "PAT team" could not agree on the major categories. The solution was to separate and individually generate a list of the processes or factors that we each felt contribute to squadron readiness. We regrouped and compared lists thus identifying a more comprehensive analysis of factors than we were able to achieve individually. We categorized and put related factors into common groups. These common groups became our major categories in the cause-and-effect diagram:

- Machines and Tools
- Aircraft
- Ship/Station Support
- Safety
- Parts Support
- Administrative Support
- Training
- Manpower

To deal with the types of group decision making problems illustrated above, a formal group decision making tool such as Nominal Group Technique (NGT) may be required. NGT is a structured, idea-generating technique similar to brainstorming that ensures participation and tolerance for conflicting ideas and builds consensus and commitment to the final outcome. (Lockheed, 1989, pp. 82)

The final step in the cause-and-effect analysis was to sub-categorize the factors and construct a fishbone diagram. Figure 7 is the result of our analysis. The major categories are represented in the boxes at the top and bottom of the

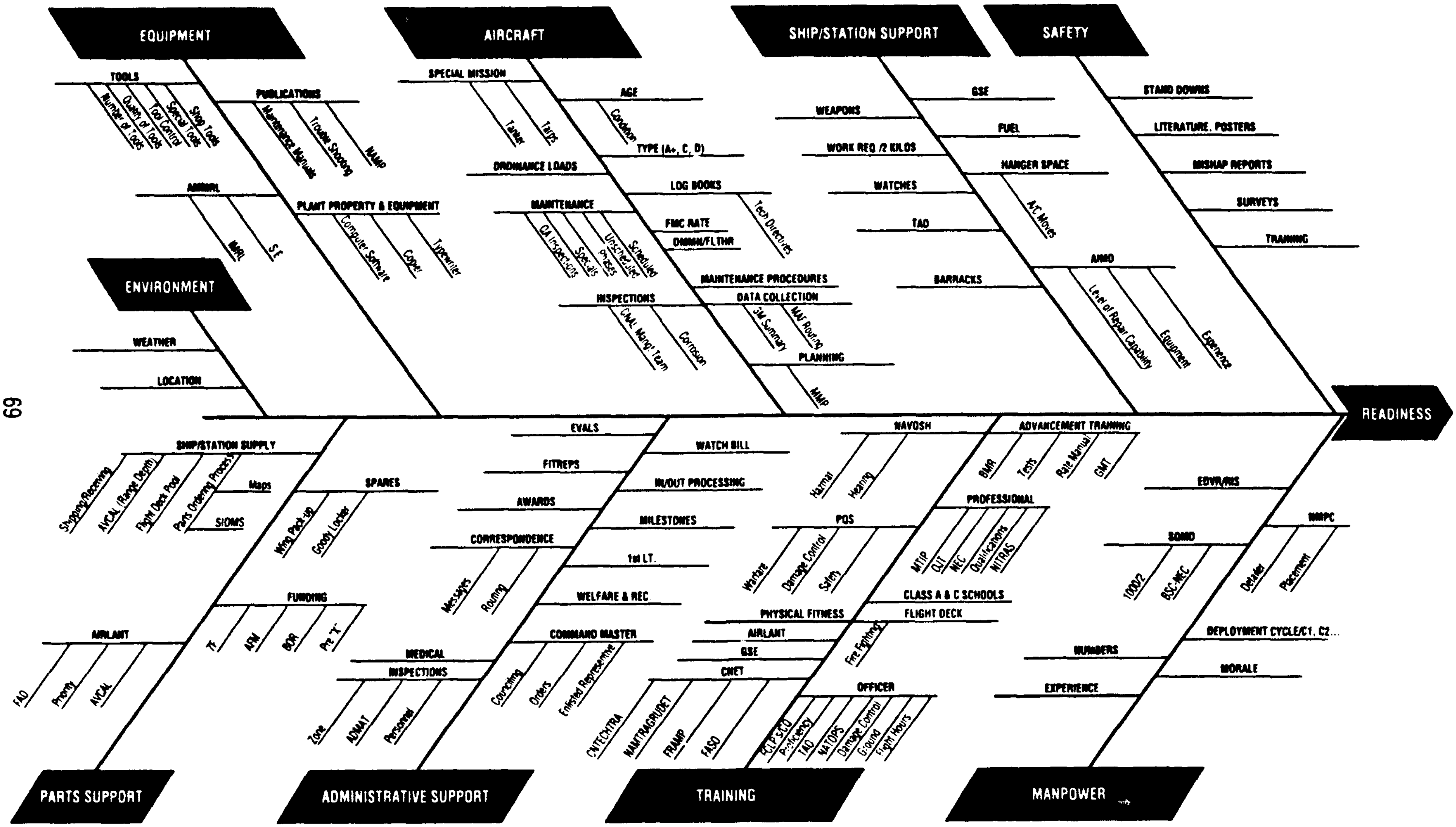

Figure 7 Cause-and-Effect

figure. This fishbone diagram will help us to find our way through the maze of activities and responsibilities in a typical squadron. It is important to note that the process of developing, analyzing and performing the cause-and-effect diagram (e.g., group discussion, debates and consensus building) is more important than how you represent the major categories and factors leading to the effect or symptom.

B. FLOW CHART

Often the first step in looking for ways to improve a process is to draw a flow chart of that process. Referring to the cause-and-effect diagram, (see Figure 7), a tertiary bone of the major category titled "aircraft" is VIDS/MAF (Visual Information Display System/ Maintenance Action Form) routing. VIDS/MAFs are the *source document* for aircraft maintenance information; this includes documenting when an aircraft is or isn't FMC. Frequently valuable data is lost because VIDS/MAFs are incorrectly documented or processed. Lets assume that there is a problem in getting VIDS/MAFS processed in a timely manner. A process cannot be improved unless everyone understands and agrees on what the process is.

A flow chart is a graphical representation which shows all of the steps or activities that constitute a process. The flow diagram is constructed from standardized symbols. The purpose of flow charting is to aid in understanding a process and identifying non-value added steps. It can be a useful tool for examining how various steps in a process are related to each other or it can be an effective tool for finding bottlenecks within a system. Flow charting can be applied to any process be it administrative or production oriented. (NAMO,1990,sec.F).

There are two types of flow charts; formal ("by the book") and actual ("as is"). A formal flow chart is a published or established way of performing a process following formalized procedures or instructions. A formal flow chart may be as simple as determining the chain-of-command. The actual ("as is") flow chart depicts a process as it actually functions -- "what really happens".

Flow charts must be produced by the people who know or are part of the process or system. A flow chart should be used to "flush out" formal descriptions of operations. It could be discovered that the "as is" description includes redundant steps or that informal processes "short cut" formal processes and provide guidance for increasing quality. The "as is" flow chart can also serve to provide a more detailed knowledge of critical processes.

For example, the "formal" VIDS/MAF routing procedures do not show that they are to be routed through Quality Assurance. The "as is" flow chart may show that there is a local requirement to route the VIDS/MAFS through Quality Assurance for data entry into the local data base. The benefit of doing a formal and actual flow chart is that it helps identify a problem by comparing the two. A flow chart is an effective tool for finding bottlenecks within a system. In this example the Quality Assurance representative was having difficulty in entering data into the computer and this bottleneck could only be discovered by doing the "as is" flow chart.

C. SCATTER DIAGRAM

The Scatter Diagram or correlation analysis is used to examine the relationship between two variables in problem analysis of the Do phase. The variables may be derived independently, but very often come from the cause-and-effect diagram. For example, referring to the squadron cause-and-effect diagram, we may want to see if there is a correlation between flight hours flown and Aviation Fund Maintenance (money available to perform maintenance). Even though the Scatter Diagram may be testing variables from the cause-and-effect diagram, it does not prove that one variable causes the other, but it does provide an indication as to whether a potential relationship exists and the strength of that relationship. (NAMO, 1990, sec. S)

The Scatter Diagram is constructed by setting up an XY graph where one variable is represented by the X (horizontal) axis and the second variable is represented by the Y (vertical) axis. A correlation coefficient may be calculated, although the strength of the correlation is often obvious just by looking at the diagram.

The value of a scatter diagram is illustrated by the following example. Suppose that the Commanding Officer wanted to increase his squadron's bombing scores at the range in preparations for the upcoming bombing derby competition. The relationship between average flying hours for the previous month and bombing accuracy may look like Figure 8.

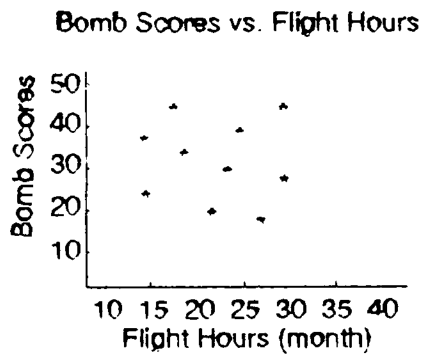

Figure 8 Scatter Diagram

Based on this data, there is no correlation between average flying hours for the previous month and average bomb scores. The next step in determining the degree of relationship between potential causes and effects would be to examine the correlation between average bomb scores and pilot experience, (see Figure 9).

The Commanding Officer could conclude from this figure that there is a positive correlation between experience and bombing accuracy. From this he could deduce that last minute

Bomb Scores vs. Experience

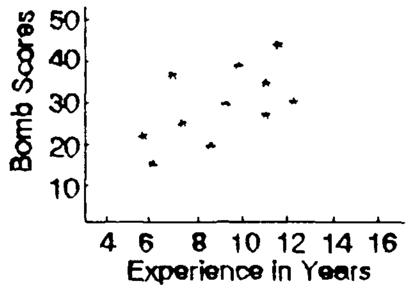

Figure 9 Scatter Diagram

training won't help, his best choice is to enter the crews with the most total experience.

D. PARETO DIAGRAMS

In our cause-and-effect diagram, (see Figure 7), one of the largest contributors of the main category titled "aircraft" is maintenance. Maintenance has numerous tertiary bones that contribute to the maintenance process. One of the methods of measuring the maintenance process is through documentation of maintenance manhours for each aircraft. Commonly one aircraft or block of aircraft may be a high manhour consumer. The maintenance data system provides the ability to look at that aircraft or block of aircraft and determine what parts are failing and leading to high manhour consumption. A Pareto Diagram is an effective indicator/tool in the "Do" phase of this scenario. The purpose of using a Pareto Diagram is to identify the biggest problem and rank the rest, or to identify the most important cause and rank the rest.

The Pareto Diagram is a specific type of column graph in which the vertical columns are arranged in descending order from left to right to picture the frequency with which related categories or classifications occur. The diagram is used to determine priorities. The one exception to the "descending order" is the "Other" category, this is a collection of minor classifications, which regardless of size, always appears on the far right of the diagram. The Pareto Diagram facilitates the analysis process by graphically distinguishing the vital few problems or causes from the trivial many. The diagrams can be employed to: establish priorities, show percentage of incident, show change over time, aid communication, or demonstrate the use of data. The data collected for plotting on a Pareto Diagram are of three major types: problems (including errors, defects, locations, processes and procedures), causes (including material, machine, equipment, employees, customers, operations, and standards), and cost (of each category of data). (CNAL,1985,pp.3)

By collecting and categorizing manhour data in our example, a Pareto Diagram was constructed to help focus process improvement efforts. Figure 10 plots the Maintenance Manhours per Aircraft. Aircraft 110 is the largest consumer

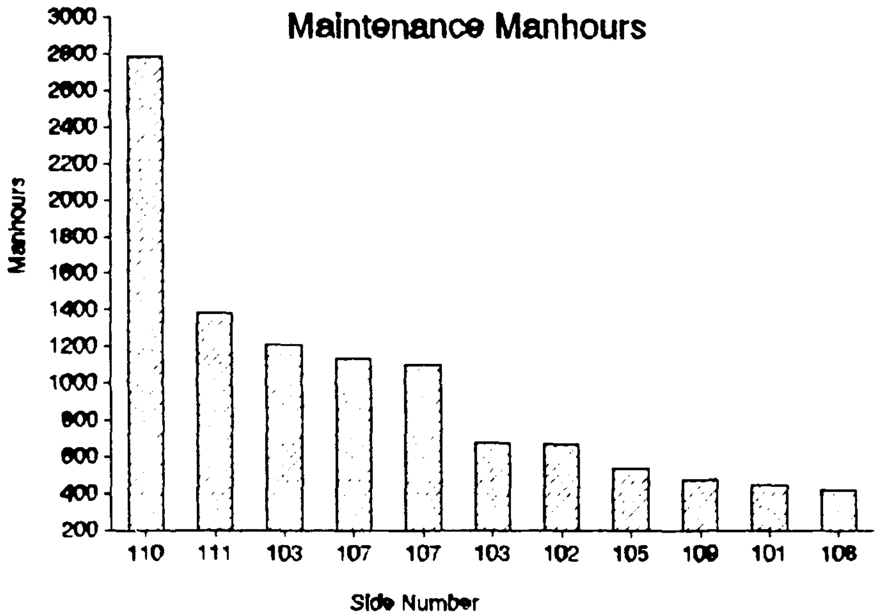

Figure 10 Pareto Diagram, Manhours per A/C

of maintenance manhours, consuming 900 MMHs more than the next leading aircraft. The first question to ask is if that is the aircraft that you want to investigate? There may be many other factors that should be considered before deciding which aircraft to investigate. For example, aircraft 110 may be waiting depot level repair. Therefore, the next highest manhour consuming aircraft should be considered.

If this aircraft is chosen as the focus for further problem analysis, the next step is to collect and prioritize

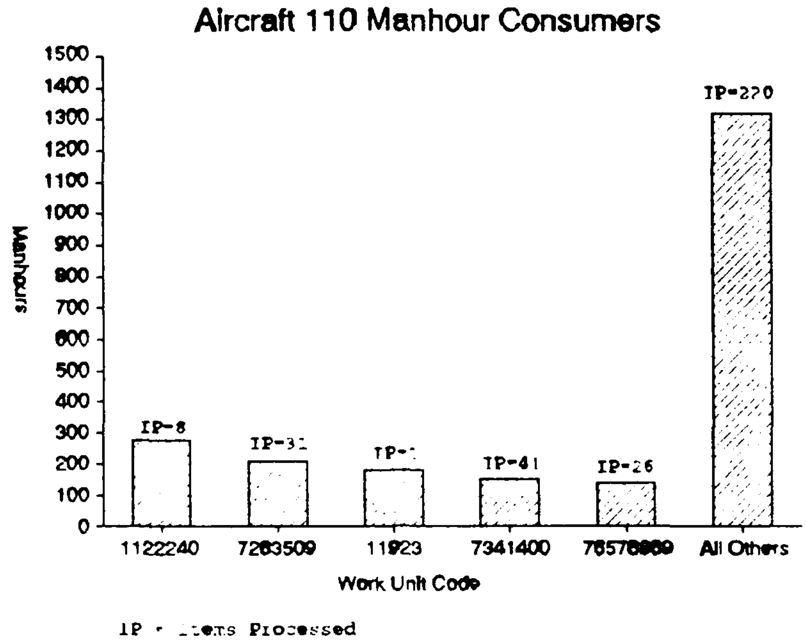

Figure 11 Pareto Diagram

data on all the subsystems of that aircraft that are consuming manhours. Figure 11 shows a pareto diagram for the subsystems that are high manhour consumers for aircraft 110, broken down by Work Unit Code (WUC). In this example, engine access doors are the highest manhour consumer. Further investigation determines that 34.5 manhours of maintenance was expended for each of the eight doors processed. By looking up this repair in the Maintenance Instruction Manual (MIM), the Work Package lists the job as taking 36 MMHs. Knowing there was a special requirement to change engine access doors this month there is no further investigation needed.

Noting that only one wing fold actuator (WUC 11923) was changed for a total of 182 MMHs lags trouble. According to the maintenance instruction manual it should only take 45 hours to change that actuator. This discrepancy suggests further analysis is necessary. Hypothetically, further investigation may reveal special causes. For example, proper tools may not have been available to do the job correctly; or the process of removing and installing the actuator was performed incorrectly and required rework. The PAT can take action on these special causes and forward this information to the QMB.

E. RUN CHARTS

Since FMC rate is scrutinized by higher authority, it is important to track it while focusing on improving processes within the squadron. The best use of FMC data is to plot it on a Run Chart. Run charts are a running plot of measurements used to visually represent data. They are constructed to determine if there are time-related patterns in process performance. They can also be used to test "before" and "after" effects of a process change.(NPRDC,1988,pp.20) A run chart will not tell you if a process is in control, but it does give a general view of the variation inherent in the process.

Most run charts are constructed with the horizontal axis representing time or sequence, and the vertical axis representing some form of measurement such as frequency, percentage, or range. The data must be plotted on the graph in the order in which it occurs. The data may reveal runs which indicate a statistically unusual event as discussed under control charts.

A run chart of the FMC rate (see Figure 12) can be used as a communication tool. Note the time line indicating the squadrons location and the comments explaining variation. Displaying a chart such as Figure 12 in a central location communicates how well the maintenance department is doing in terms of aircraft readiness.

F. CONTROL CHARTS

1. Proper use of a Control Chart

Process improvement is a matter of attacking variation in process output. The control chart is a statistical tool which helps management tell the difference between normal and abnormal variation. These charts depict process performance from samples taken over a period of time. It assists in indicating when a process goes beyond (pre-established) control limits and thus appropriate action may be necessary. Control charts can be used to predict how a process should perform under stable conditions. These charts can be used to distinguish among variables that consistently affect all of a

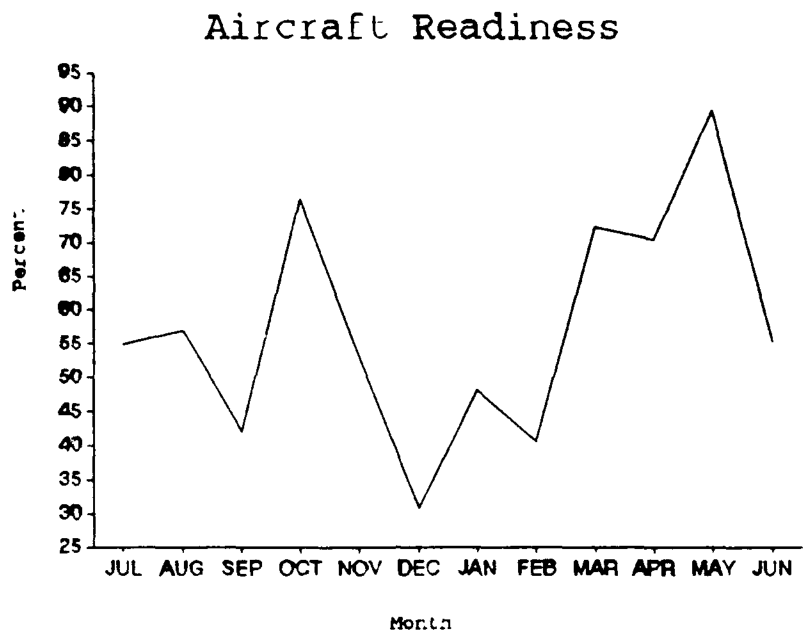

Figure 12 Run Chart, FMC Rate

processes' outputs ("common causes") and those that have an unpredictable effect on outputs ("special causes"). The control chart can also be used as a monitoring tool to assess effects of process control[5] and process improvement efforts.

A control chart is simply a run chart with statistically calculated upper and lower control limits drawn

[5] Definition of Control - control refers to process consistency, not quality and a process is to be said to be in control when through the use of past experience, we can predict at least within limits, how the process may be expected to vary in the future.

on either side of the process average. These limits are calculated by standard formulae available in most basic statistics text books. The control limits on a control chart tell the amount of variation that is to be expected from a given process but it does not determine a quality performance standard. The manufacturing industry generally uses three standard deviations for determining upper and lower control limits. Customer's requirements do not form a basis for calculation of control limits. Note: Specification limits (tolerances) should never be shown on a control chart.

Plotting data on the control chart you can see the frequency of data points falling outside and inside the control limits, and whether they form discernable patterns. If all points fall within the control limits, the process is said to be "in control".

Based on probability, points that fall outside the control limits come from "special causes" such as single engine approaches, bad weather, unplanned events, etc., that are not a part of the normal operating procedures. These points must be examined to determine if it is reasonable and economically feasible to investigate the special cause. If it is, the people actually working in the process are responsible for taking action, correcting special causes, and regaining control of the process.

Points that fall within the control limits are the result of normal variation that is inherent in every process.

This variation is due to "common causes" within the system elements, and can only be affected by management making changes to the system to reduce this variation.

Management must also look for discernable patterns in the data which provide signals that process adjustments may be necessary in order to make improvements. A "run" of plotted data on one side of the average indicates a statistically unusual event and most likely a change on the average. The grounds exist for suspicion that parameters (e.g., mean performance or one of the control limits) have changed whenever in seven successive points on the control chart, all are on the same side of the mean, or whenever more than 80% of successive points on the control chart are on the same side of the mean. If the run chart reveals a pattern of six or more points (anywhere on the chart) steadily increasing or decreasing with no reversals, or a reoccurring pattern (e.g., zig zag), this also indicates a possibility of non-random variation. These types of patterns or trends should be investigated. Further data on identifying statistically unusual events that may change the parameters can be found in most statistics text books.

2. Squadron Control Charts

We have gone into extensive detail in describing control charts because they are usually the focal point for discussions of TQL and statistical methods. Commonly squadrons incorrectly plot FMC rate on a control chart. They frequently miscalculate the upper and lower control limits, using the monthly FMC data from the previous 12 months. Twelve data points are not a sufficiently large sample to adequately establish upper and lower control limits. As a general rule at least 30 points are needed.[6]

We also found it difficult to apply control charts in an aviation squadron. A squadron does not perform the same processes as an industrial manufacturer. The dynamic environment creates three problems (1) the geographical location is always changing, (e.g., shipboard operations, weapons detachments at Fallon, NV., and shore based operations at home bases), (2) most measurements like our FMC example contain too many variables to be considered a continuous process, (3) due to the infrequency of most processes it is difficult to gather enough data points to be sufficient for decision making. Again, consider FMC rate. The squadron FMC rate changes depending on the location of the squadron, each monthly FMC data point contains the output of many squadron processes, and in the length of time it would take to collect enough data points, too many things have changed to determine any kind of corrective action.

Although control charts are advertised as a main ingredient to TQL, most squadron processes are not suitable

[6] Statistical theory may allow less points or require many more points.

for control charts. Squadrons should consider the process and the reason it is being examined when choosing a statistical tool, using caution to choose the tool which best fits the process (e.g., plotting FMC rate on a run chart vice a control chart).

G. HISTOGRAMS

A process can be better understood by examining the usual process patterns or variation encountered. The histogram is one of the tools in the "Check" phase that can help keep track of variation. The Histogram is simply a "snapshot" of a process at one point in time that shows (1) the spread of values that a specific measurement gives, (2) how many of each value there are, and (3) the shape of the distribution. (NAMO,1990,sec.H)

Data gathered about any set of events, series of occurrences, or any problem will show variation. If a given process is measurable, the numbers will vary. Variation is found in all processes. When these data are tabulated and arranged in time sequence, the result is a frequency distribution. The frequency distribution will indicate where the data are grouped and will portray the variation.

Histograms are effective tools because they show the actual distribution. It is a column graph depicting the frequency distribution of data collected on a given variable. It visualizes how the actual measurements vary around an average value. The frequency of occurrence of each given measurement is portrayed to be the height of the columns on the graph.

The typical histogram has a three part focus. The center of the histogram defines the current performance level of the process (this may be independent of where you want the process to be). The width of the histogram defines the variability. The shape of the histogram can also shed light on the variability of the process. For most characteristics, a normal or bell-shaped curve is desired. However, other data might display different patterns. For example, data can be skewed, bimodal, or out of specification. Any significant deviation from the normal pattern may suggest further investigation. (Juran, 1988, 16.15)

Referring back to our example of turning around aircraft after recovery, we can demonstrate the usefulness of a histogram (the specifics on constructing a histogram can be found in any basic statistics book). The QMB has set up a PAT to improve the turnaround process. The Maintenance Instruction Manuals states that the process should take 40 minutes. The PAT can record the time it takes to perform each turnaround. The PAT could then construct the histogram by plotting the frequency of occurrences of each value, e.g., 20 turnarounds took 45 minutes, 12 took 30, etc.

From the histogram the PAT might conclude that the turnaround process is erratic and not capable of being performed consistently in 40 minutes. This means that the process can not be predicted. The next step might be to flow chart the process to determine the special causes.

VII. CONCLUSION

A. RECOMMENDATIONS FOR FURTHER STUDY

During the research on applying TQL to a squadron several issues came to light which would be good topics for future study.

1. Officer Fitness Reports and Enlisted Evaluations

The competition created among individuals by the current fitness reports and evaluations may deter full implementation of TQL in a squadron. A study of this topic could consider criterion oriented appraisals as contrasted with the current normative appraisals. Using group appraisals and awards versus the individualistic competition could also be explored.

2. Training

The general training is done informally at the squadron level through peer teaching peer. Two studies could be done on this topic. First, a study could be done to examine the training requirements, costs (including opportunity costs of time in training) and value added. Second, a study could also explore how the squadron mission is reinforced by training and what other training approaches and methods could be used.

3. Squadron Performance Measurements

Squadron performance is measured using criteria such as Full Mission Capable Rate, Mission Capable Rate, Sortie Completion Rate, Flight Hours and many others. The performance standards are set without regard to the capability of the squadron, e.g., current manning level, number of aircraft, etc. This topic could explore the use of standard tools using historical data to determine the actual capabilities of aircraft squadrons. What criteria could aircraft wings use to determine which squadrons are in control and which are not?

Additional research could be done to further develop the use of process improvement tools in fleet units. Data gathered in the actual application of tools from squadrons implementing TQL may show the special contributions and limitations of special tools to process analysis.

4. TQL Squadron Implementation

Several aircraft squadrons are correctly implementing TQL. A follow-on topic to the research done in this thesis is to study the actual implementation of TQL in these squadrons. How are the ESC, QMB and PATs set up and who are their members? Is a TQL coordinator used and what position does he/she have in the squadron? How long does implementation actually take? What are the barriers to implementation?

B. PERSONAL LEARNING POINTS AND IMPLEMENTATIONS

The process of researching and writing this thesis has provided the authors with a solid understanding of Total Quality Leadership and its potential within the Navy, naval squadrons, and especially within aviation maintenance. The authors are reporting to two different billets in the aviation maintenance community: project officer at a Naval Aviation Depot (NADEP) and division officer at an Aviation Intermediate Maintenance Department (AIMD) on board an aircraft carrier. The personal implementations of TQL in these billets will differ according to the level of maintenance, rank of the individual, type of command and the current state of TQL implementation at the organization. The following represents the personal plans of each author for the application of knowledge acquired in the work of this thesis.

1. AIMD Division Officer

As a junior lieutenant checking aboard a carrier as a division officer I plan to take a subtle approach of implementing TQL. The carrier has not initiated a formal TQL implementation plan, the Captain's, and department heads', and crew's attitudes on TQL are unknown. A junior lieutenant just checking on board does not have the experience or credibility to convince subordinates and seniors what the ship's philosophy on quality should be.

Clearly, waving the TQL banner and touting all the advantages of Deming's philosophy and TQL would do little to convince people and could do more harm by building resistance to change. A lieutenant new to a large organization would be more successful using an indirect approach. A division officer can lead and manage the division using the principles of TQL without convincing anyone.

The most important thing I can do is acknowledge that 85% of all problems are caused by the system and not the worker. This acknowledgement will focus my attention in problem solving on the processes not the individual sailor. Reports and data analysis used in the division can be changed to reflect the processes, not the results. Processes within the division can be analyzed using the proper statistical tools. Process improvement training can be done at the work center level. Group problem solving techniques can be used to promote teamwork and open communications.

A division officer can successfully lead the division using the principles of TQL without using or saying the words Total Quality Leadership. An indirect approach at this level will gradually work the principles of TQL into the ship's culture in small areas of the organization. When the official push for implementing TQL comes from the top some areas of the ship will be less resistant to the change.

2. **NADEP Program Officer**

The NADEP I am reporting to has been heavily involved in TQL since the mid-eighties. As a Program Officer I will probably be assigned as a team member and TQL advisor. My role will be implementing TQL via leadership. I will keep the critical mass motivated thorough understanding of total quality and to be committed and actively involved in the process.

As a Program manager I must strive for a system under which management decisions are based on data rather than on just experience, on quality more than simply cost savings. I will seek long-term strategies, not just short-term gains; effective methods, not just financial targets; and innovation rather than status quo.

APPENDIX A

Reading List

Walton, Mary
The Deming Management Method
Forward by W. Edwards Deming
Reprint. New York, NY: Putnam Publishing Group, 1986.
(An introduction to the Deming philosophy with detailed, step-by-step instructions, illustrations, and worksheets, all showing how to implement many quality improvement principles.

Deming, W. Edwards
Out of the Crisis
Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1986.
(Discussion of American Management failure and Dr. Deming's remedies for today's business problems.)

Imai, Masaaki
Kaizen: The Key to Japan's Competitive Success
New York, NY: McGraw-Hill, 1986.
(Discusses industrial management in Japan and comparative management.)

Juran, Joseph M.
Juran on Leadership for Quality: An Executive Handbook
New York, NY: Free Press, A Division of MacMillan Inc., 1989
(Focuses on challenges faced by senior managers who must lead their corporations on the quest for superior quality. Offers proven, field-tested methods and shows why and how strategic quality management must come from the top.)

GOAL/QFC
The Memory Jogger, A Pocket Guide of Tools for Continuous Improvement
Methuen, MA: 1988, phone: (508)685-3900.

Sink, D. Scott
Productivity Management: Planning, Measurement and Evaluation, Control and Improvement.
New York, NY: John Wiley and Sons, 1985.

APPENDIX B

Function		*Tools*	
Idea Generation		Affinity diagram Brainstorming	Cause-and-effect diagram Nominal group technique
Planning		Critical path	
Analysis	▪ ***Statistical***	Benchmarking Design of experiments Frequency table Histogram Pareto diagram	Run chart Scatter diagram Statistical process control and capability Statistical tests
	▪ ***Relational***	Affinity diagram Cause-and-effect diagram CEDAC (cause-and-effect diagram with the addition of cards) Flow chart Force-field analysis Interrelationship graph	Matrix diagram Quality function deployment Tree diagram Window analysis
Data Gathering		Check sheet Concentration diagram Customer survey/interview	Run chart Statistical process control

(Lockheed, 1990, pp. 61)

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COMNAVAIRLANT, *Introduction to Basic Statistical Quality Control,* NAS Norfolk, VA, 1985.

Deming, W. Edwards, *Out of the Crisis*, Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, 1982.

DeCosta, Interview between R.DeCosta, IBM, and N.F. Melnick, 25 July 1991.

Fisher, George, "Customers Drive a Technology-Driven Company," *Harvard Business Review*, Vol. 60, No. 5, September-October, 1989.

Florida Power and Light, "Policy Deployment," unpublished paper, 1989.

IBM (International Business Machines), *Process Control, Capability and Improvement*, The Quality Institute, New York, 1984.

Imai, Masaaki, *Kaizen: The Key to Japan's Competitive Success*, Random House, New York, 1986.

Juran, Joseph M., Gryna, Frank M., and Bingham, R.S., *Quality Control Handbook*, 3rd Edition, McGraw-Hill, New York, 1951.

Lockheed Corporation, *Guidelines and Tools for Continuous Improvement*, A Resource for Quality Improvement and Management Within Lockheed Corporation, 1990.

Naval Aviation Maintenance Office, *Continuous Process Improvement (CPI) Graphical Tools Training Guide*, Student Handbook from the NAMO Total Quality Leadership workshop, NAS Lemoore, 1990.

NPRDC (Navy Personnel Research Development Center), TR 80-3, *A Total Quality Management Process Improvement Model*, by Houston,A. and Dockstader, S., December 1988.

Salvanera, Rolando C., *Implementing Total Quality Management at the Intermediate Level of Aircraft Maintenance*, Master's Thesis, Naval Postgraduate School, Monterey, California, June 1989.

Schonberger, Richard, J., *Operations Management Improving Customer Service*, Irwin, Boston, 1991.

Stein, Jess, *The Random House Dictionary*, Random House, New York, 1980.

Strickland, Jack C., "Key Ingredients to Total Quality Management," *Defense 89*, March/April 1989.

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